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# MANUAL

OF

# GENERAL ANATOMY:

OR,

## A CONCISE DESCRIPTION

OF

THE PRIMITIVE TISSUES AND SYSTEMS WHICH COMPOSE THE ORGANS IN MAN.

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BY A. L. J. BAYLE, D.M.P.
&c. &c. &c.
AND
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TRANSLATED FROM THE FRENCH BY

HENRY STORER.

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TO

# WILLIAM WRIGHT, Esq.

FELLOW OF THE ROYAL COLLEGE OF SURGEONS IN LONDON,

MEMBER OF THE MEDICO-CHIRURGICAL SOCIETY,

AND FOR MANY YEARS SURGEON TO THE LATE CORPS OF

THE LIGHT HORSE VOLUNTEERS,

THIS VOLUME

IS RESPECTFULLY DEDICATED,

AS A SMALL BUT SINCERE ACKNOWLEDGMENT

OF KINDNESS RECEIVED,

AND PROFESSIONAL ADVANTAGES ENJOYED,

BY HIS VERY OBEDIENT

AND OBLIGED SERVANT,

HENRY STORER.

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# PREFACE.

THAT ANATOMY is the foundation of all medical and surgical knowledge, is a truth so generally admitted, that to enlarge on its importance might appear superfluous.

The science of ANATOMY comprises two principal divisions: the one, *Practical or Descriptive;* the other, *General,* and of which this volume presents an epitome.

That GENERAL ANATOMY has hitherto been much neglected, is undeniable; and as a proof of this assertion, it need only be noticed, that to this period no works have been published exclusively on this subjeet in English, except Bichât's writings, which have been translated from the French: these, however valuable, are, from their size, inaccessible to many readers. GENERAL ANATOMY possesses the strongest elaims on our attention, as being the only solid basis on which *Practical Anatomy* can be properly studied; by affording us a knowledge of the primitive tissues of which the body is composed.

In offering this Manual to the notice of the Medical Profession, the Translator does not for a moment presume that it will, or ought to, supersede more extensive enquiries on the part of those who may have time or inclination for them; but he trusts he is fully justified in stating, that the present volume is calculated to fill a chasm which appears to exist, by presenting much valuable information in a condensed yet comprehensive form.

Although chiefly designed for the MEDICAL PROFESSION, yet it is conceived it may be useful to those scientific and literary individuals who wish to become acquainted with the general principles of Anatomy.

With respect to the translation itself, the Author has endeavoured to give the meaning of the original, in those words which he thought would be most expressive; and he has therefore, in many instances, adopted a style which, though not elegant, has at least the advantage of being intelligible.

3, Grenville Street, Brunswick Square,
September 1829.

# INTRODUCTION.

LIFE results from the action of numerous instruments, called *Organs,** which are connected together by various means, with more or less intimacy, according to the secondary uses for which nature has destined them. These organs have hitherto been generally studied with regard to their actual condition, that is, with regard to their forms, structure, and physical characters; and, together with their acts or *functions,* have formed one sole branch of science, namely, Physiology. But as our acquaintance with organization became more intimate, we were necessarily obliged to separate these two studies. The conformation, situation, and structure of organs, form one branch of science, called Anatomy; while Physiology more especially comprises the history of the functions of the animal economy.

Anatomy is also subdivided into two branches, viz. *descriptive* and *general* Anatomy. The former, or

descriptive Anatomy, is the study of every part which possesses some peculiar action, and of every organ which has a function to perform. It describes their physical and external properties, their situation, volume, form, and connections, and demonstrates their organization, or mutual arrangement of the primary tissues of which they are composed. The latter, or general Anatomy, consists in describing their primary tissues and organic systems in a general manner.

We give the name of *Tissue* to every species of any part of the animal solids, which possesses characters peculiar to itself, and differing from those of the other species. Tissues are the constituent parts of our organs, or, in other words, they are their elements. The term of *System* is given to each tissue, according to its structure, without reference to the part of the body which it may occupy.

The solids compose the smaller portion of the human body. The remainder is formed by the fluids, which abound to a very considerable extent. Before we enter into an examination of the organic systems, let us say a few words upon the fluids, which perform so great and so important a part in the animal economy. Though this subject has for ages formed the exclusive study and fixed the attention of medical men, yet mo-

dern physiologists have laid it aside, and now seek for the seat of every disease in the solids.

## *Of the Fluids.*

It is impossible to determine with accuracy the relative quantity of the solids and fluids. Some suppose the fluids to bear to the former the proportion of 6 to 1: while others estimate it as 9 to 1.

The fluids, or humours, are contained in the solids, and penetrate more or less into them, according to the species of organ under examination. Their liquidity depends more on the vital action than on the quantity of caloric they contain. In fact, the greater number of them coagulate when removed from the body, although they may be exposed to a high temperature.

The animal fluids may be divided into three species; viz.

1st. The blood, which is the nourishment and receptacle of the other fluids.

2nd. The fluids which are poured into the blood.

3rd. Those fluids which are furnished by the blood

### 1st. *Of the Blood.*

The blood is a fluid contained in the heart and blood-vessels. Its quantity is estimated from 8 or 10lbs to 80 or 100.

It is of a red colour, is viscous to the touch, saltish and nauseous to the taste, of a peculiar odour, of a temperature equal to that of the body, and of a specific gravity of 105, water being rated at 100.

The microscopical researches of Hewson, Béclard, Prévost and Dumas, tend to prove that the blood, when examined in its vessels and in motion, is formed of a serous fluid, in which red particles of a lenticular form float. These particles are composed of a central globule, which is whitish, transparent, and contained in a red, though less transparent, envelope.

When the blood is removed from the vital influence, it gradually loses its heat, disengages a considerable quantity of carbonic acid gas, and coagulates. It soon after separates into two parts; the one, solid, called the *crassamentum*, or clot, and the other fluid, called the *serum*. By washing the coagulum, it is separable into two other portions: one is the colouring matter of the blood, which remains suspended in the water; the other is solid, consistent, and whitish, and

constitutes the fibrinous part of the fluid, now described.

The *serum* has a greenish yellow tint; its smell and taste are similar to those of the blood. It is alkaline and coagulable at 156° Faht. It is composed of water, albumen, soda and its salts. Brande considers the serum as a combination of this base with albumen, and calls it the albuminate of soda, with the latter in excess. The colouring matter of the blood results from the mixture of free red matter and serum, and is capable of presenting various shades of colour. It is insoluble in water, in which it is divisible ad infinitum. Chemistry has taught us nothing positive on the nature of this substance; it appears composed of animal matter, in union with a peroxide of iron.

The fibrine of the blood, called by many authors coagulable lymph, is very analogous to the muscular fibre. When seen through the microscope, it resembles it exactly, and presents white globules, similar to those of the colouring portion. Fibrine is composed of solid, tenacious, whitish, fibres. The blood contains also a fatty, or oily matter.

Blood, in the living animal, is submitted to the impulse of the heart, which, with the aid of various other causes, circulate it incessantly through its cavities, and through the arteries and veins. During its passage,

this fluid undergoes continual changes in its composition and nature, in order that the various organs may receive their proper nourishment. The blood is renewed and replenished by the chyle, which is poured into it by the thoracic duct. It is the receptacle of the product of universal absorption, and thus receives all the molecules which cease to form part of the organs. It is regenerated during respiration, when it parts with a considerable quantity of serum and carbon, absorbs oxygen, and passes from its brownish red colour to a bright scarlet. This change enables it to become the nutritive source of all the secretions, and to form the vital principle of all the tissues into which it enters.

The blood presents numerous varieties, depending on many circumstances. It is frequently changed during disease, and in fact may become the primary seat of some very formidable complaints, and prove the vehicle of morbific principles. Thus, in fevers and in most acute inflammations, it is covered by a greyish and fibrinous layer, called the *buffy coat*. In diseases of a weak and cachectic character, as in scurvy, it is less thick, has not so much colour or fibrine, but contains more water. In putrid fevers, particularly of a contagious character, it is blackish, dissolved, and less coagulable; and will often communicate the disease of the patient from whom it has been taken.

## 2nd. *Fluids which are poured into the Blood.*

There are two of these fluids, the *chyle,* and the *lymph.* The chyle is formed from the changes that the food, or chyme, undergoes, after it has passed into the duodenum. It is a whitish fluid, which coagulates with difficulty, when seen in the lacteals a short time after it has been absorbed from the small intestines. In the mesenteric glands, its characters undergo a sensible modification. It is more coagulable, and presents a pink tinct, which becomes of a rosy colour in the thoracic duct. When examined by the microscope, this fluid presents globules and particles, similar to those of the blood, with the exception of their colour, which is much lighter.

The lymph is a transparent, colourless, viscid, albuminous, fluid, and is considerably less abundant than is usually supposed. It is contained in the lymphatic vessels, and is mixed with the chyle in the thoracic duct, after that fluid has been absorbed from the small intestines; as, for instance, after a meal.

### 3rd. *Fluids which are furnished by the Blood.*

All the particles which enter into the composition of our organs, or are rejected from the body, are derived from the blood, and are originally in a liquid state. These fluids may be divided into three kinds:

1st. Those which assist directly, in the assimilation, the growth and reparation of our organs, or the nutritive fluids.

2nd. Those which are deposited in certain cavities and interstices of our organs, such as the fat, serosity, and synovia; or which are exhaled from the surface of the body, as the cutaneous and pulmonary perspiration.

3rd. Those which are furnished by the blood and are afterwards submitted to the action of certain organs, called glands, and which result from this process; such as the mucus, sebaceous matter, tears, saliva, bile, pancreatic juice, milk, semen, urine, &c.

### *Of the Tissues and Organic Systems.*

It is very difficult to determine the exact number of the elementary tissues of the body; since many are merely modifications of each other, and since there is

much discrepancy of opinion among authors on this subject. Some (Mascagni) consider the solids to be formed entirely of vessels; and others, that they are derived from the cellular tissue. Haller has admitted three kinds of primary tissues in the composition of our organs; the cellular, muscular, and medullary tissues. Chaussier has added to these the albugineous tissue, which enters into the composition of ligaments. Richerand also admits these four tissues, and adds the horny, or epidermoid, tissue. Bichât divides them into twenty-one; among which are three generative tissues: these are the cellular, nervous of animal life, nervous of organic life, arterial, venous, exhalent absorbent, osseous, medullary, cartilaginous, fibrous, fibro-cartilaginous, muscular of animal life, muscular of organic life, mucous, serous, synovial, glandular, dermoid, epidermoid, and pilous, tissues. Béclard has united many of the preceding systems under the same denomination (as J. F. Meckel did before him), and has described successively the cellular tissue, the serous membranes, the tegumentary membranes, the vascular system, the glands, the ligamentous tissue, the cartilages, the osseous tissue, the muscular and the nervous systems. For our part, though we admit the systems as established by Meckel, we have adopted an arrangement slightly different from

those hitherto followed. It has been our aim to dispose the tissues in the most convenient manner for explaining their progressive complication of structure. Thus, we have placed, after the cellular and vascular systems, those which are only modifications of the former, which present only vessels in their organization, and which are completely deprived of nerves. These are the serous, fibrous, cartilaginous, and osseus, systems. After these follows a second series; at the head of which is the nervous system, which is composed of tissues formed by a cellular net-work of vessels and nerves; viz. the tegumentary, glandular, and muscular, tissues.

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## ERRATA.

Page 32, line 19, *for* thicker *read* stronger
156, 17, *for* or fixed or moveable *read* a mixed kind, fixed and moveable
172, 11, *for* osmarone *read* osmazome
266, 5, *for* tenth month *read* tenth week

# MANUAL

OF

# GENERAL ANATOMY.

## CHAP. I.

## THE CELLULAR SYSTEM.

### SECTION I.

### THE CELLULAR TISSUE, PROPERLY SO CALLED.

SYNONOM: Cellular substance, body, membrane, and organ: mucous, glutinous, areolar, reticulated, laminated, and filamentous, Tissue.

*Definition.*—The name of cellular is given to that soft, spongy, whitish substance, which is spread throughout the whole body, is interposed between our organs, unites them together, surrounds them, penetrates into them, and forms part of their structure.

*Division.*—This tissue forms one single body; but we can easily see that it is variously placed with regard to certain organs, and that it is more or less intimately connected with them. We shall, therefore, divide it into *general* or *common*, and into *special*. All which we have to say upon the

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manner in which the cellular tissue is disposed throughout the animal economy may be referred to these two divisions, and we shall at once commence the investigation of the general or common.

I. *The common cellular tissue.*—Its general appearance presents the same form as that of the body, which it completely envelopes. Over it lie the tegumentary membranes, and these are the only organs which it does not enclose. It does not exist in the same quantity all over the body. As we proceed from the exterior internally, we find it very abundant under the skin, particularly on the face, on the anterior and lateral surfaces of the neck, on the thoracic and abdominal parietes, on the scrotum, in the neighbourhood of the great articulations, particularly in the axillæ and groins, between the layers of the mediastinum, round the great vessels, in the abdomen, particularly surrounding the kidneys, between the folds of the peritoneum, but still more abundantly round the organs contained in the pelvis. This disposition is exceedingly well adapted to the changes these organs undergo in their volume during the exercise of their functions. On the contrary, this tissue is deficient in quantity on the median line (except at the neck), under the integuments of the cranium, in the cavity of the latter, and in the spine, particularly between the dura mater and bony parietes. The external and internal parts of the general cellular tissue communicate with each other by those intervals which are left between the contained organs; but this takes place in a much more remarkable manner by those orifices and inter-organic spaces which give passage to vessels and nerves. Thus the foramina of the cranium and spine admit of this communication. The cellular tissue of

the neck and arms penetrates into the thorax, together with the vessels and nerves, which enter and go out by the superior part of this cavity. It passes from the latter into the abdomen together with the œsophagus, aorta, and vena cava; and, lastly, it communicates with the inferior extremities through the crural arch and inguinal ring.

II. *The special cellular tissue.*—In considering this tissue with regard to its direct relations with organs, we see them furnished by it with a particular envelope, an isolated atmosphere, as Bordeu called it, before it penetrates into their internal parts.

1. *The cellular coat, which covers our organs,* is formed by a condensation of the general cellular tissue, of which it is a continuation. Its thickness varies much. It is more abundant round parts subject to much motion, and those which are not covered by a membranous envelope; as, the thyroid gland, kidneys, &c. On the muscles, it is termed their common membrane. The skin, the mucous and serous membranes, the vessels, and external passages, have only their attached surface covered by a layer of cellular tissue.

*a.* Beneath the skin, this layer is not every where equally thick and compact. It is more so in the palms of the hands, soles of the feet, round the annular ligaments, and on the median line. On the other hand, it is much thinner on the palpebræ and scrotum.

*b.* The submucous layer is generally much more dense than the former. Serum seldom accumulates in it; and this forms an indispensable character; as, otherwise, the muscles, which are inserted into it, would have no support.

*c.* The serous membranes, which are more particularly formed to allow of different degrees of motion, are provided,

on their attached surface, with a loose cellular membrane, as in the peritoneum. But the pericardium, synovial membranes, and arachnoid, always adhere closely to their organs; the former at certain parts only, the two latter by nearly the whole of their surfaces.

*d.* The blood vessels, lymphatics, and excretory ducts, are enveloped by true cellular sheaths. The sheaths of the arteries are so dense as to preserve their cylindrical form when separated from the vessels; those of the excretory ducts are rather less dense, and those of the veins and lymphatics are still less so.

Those organs which are composed of many membranes, placed one over the other, have the intervening cellular tissue of different densities. That which belongs to the submucous and subserous layers of the intestinal canal, and to a portion of the bladder, and which, when considered in relation to the coats of the canal, is called the external cellular tissue, may really be regarded as the internal cellular tissue, provided we embrace all the organs now under consideration. It forms, in fact, a transition between the foregoing and the following subdivisions.

2. The cellular tissue, which *enters into the internal composition of organs,* envelopes even the most minute parts of their substance. Thus, every fascia, each muscular fibre and fibril, the glands, and each minute molecule of which they are composed, appear to have a cellular sac, or sheath. This sac is, of course, the more attenuated, the smaller the organic particle is, which it envelopes. A looser cellular tissue than that which forms these sacs separates them from each other. In short, the internal cellular tissue performs the same office in the constituent parts of organs, that the

general cellular tissue does on the organs themselves. Very little cellular tissue is discovered in the brain and spinal marrow, in the bones and ligaments; and it is only by long maceration that it can be traced in the cartilages.

*Structure.*—What is the internal conformation of the cellular tissue? If we examine a portion of it, which is free from fluidity, it has the appearance of a homogeneous, semi-transparent substance, or of a lamellated, filamentous texture. The former belongs particularly to the special, the latter to the common cellular tissue. If we separate two parts, which are united by cellular tissue, it appears to form, 1st. Transparent lamellæ, or plates, in those parts where it is loose; as in the palpebræ and scrotum: 2nd. Filaments, sometimes single, sometimes interlaced with lamellæ, which never exist without the former. Both are soft and white, and they are capable of being much attenuated by distention, without being ruptured. If air or liquids be introduced into this tissue, they spread over it with the greatest facility, and occupy the irregular areolæ, which are formed by the crossing of the lamellæ and filaments just mentioned. These areolæ are particularly visible when water is frozen in them. Haller and Bichat, and more lately Béclard and De Blainville, as well as most English and Italian physiologists, have concluded that the cellular tissue has a lamellated and filamentous texture, and possesses permanent areolæ, which are irregular, variable, and communicate together. Borden, however, considered this membrane to be a homogeneous, shapeless, viscous substance, a kind of *gluten*. Wolff, and, more lately, Rudolphi, Heusinger, J. F. Meckel, &c. have adopted this idea, and have affirmed that the lamellæ, filaments, and cells, do not exist till the membrane is distended

to shew them. They say that they are caused by this distention, and that the same phenomena would be remarked in a mass of mucus or glue, if submitted to the same cause. Hence they have described the cellular tissue by the name of the mucous tissue.* We may answer to this: 1st. That the texture of the cellular tissue is evident, without distention, in many parts.† 2nd. That its permeability is too remarkable to belong to a homogeneous, viscous, substance ;‡ and that, as it appears to be an areolar, spongy tissue, we must still continue to regard it as such.

'Our ideas on the nature of the cellular tissue are but vague and hypothetical. Meckel observes in it a *fluid in a state of coagulation*. Ruysch and Mascagni say it is composed of vessels; and Fontana, of tortuous cylinders. Whatever may be the fact, this tissue receives capillary vessels, which it supplies with parietes, and which never carry red blood, but in a state of inflammation. The nervous filaments, which can be traced there, seem to have no relation with it.

*Variations from age.*—The cellular tissue, which forms the base of all the rest, is represented during the first period of pregnancy by a viscous substance, in the midst of which the other organs are developed. This substance diminishes, acquires consistence, and passes through the condition of mucus and gluten, to become at length that texture which we

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* Can an omorphous, homogeneous, substance, be called a tissue, as is supposed by these authors ?

† Meckel appears to confess this fact, when he says that the contrary opinion to his own is at least too general.

‡ After wounds of the lungs, the air sometimes penetrates into the cellular tissue with such promptitude and facility, that it cannot be explained, without admitting the pre-existence of cells.

see. Bichat certainly exaggerates when he says that filaments and lamellæ exist in the rudiments of the embryo, but that they cannot be seen, from their tenuity, and the quantity of fluid which fills their interstices. The mass of general cellular tissue diminishes in proportion as the organs are developed, but it still predominates for many years after birth. The same thing occurs during the greater part of life in the female sex; hence that roundness which is common to females and infants. In the latter, the cellular tissue is more delicate, its serosity more abundant, and its vitality more energetic, than in the subsequent periods of life. In the adult it acquires a certain firmness, it is less fluid, forms thinner coats, and allows the subcutaneous organs to pass out. In old age it is dry, inelastic, and, as it were, withered. This condition is partly the cause of the wrinkles which appear on the faces of old people.

*Physical and chemical properties.*—The cellular tissue is nearly colourless, when distended, but appears of a greyish white as soon as it forms a thin layer. Its cohesion, which is in the direct ratio of its density, offers every imaginable degree between that of mucilage and of the fibrous tissues. It is peculiarly elastic.

The cellular tissue is very slowly decomposed. It resists, for a long time, the action of the gastric juice, and of boiling, and requires many months to macerate it. Gelatine is the immediate predominant principle in this tissue; it also possesses some fibrine and calcareous salts.

*Vital properties.*—The sensibility of this tissue is very obscure in health; it is susceptible of some very evident vital changes.

*Functions.*—The general cellular tissue serves to unite

organs together, and to facilitate their motions by its suppleness and elasticity. That which more especially belongs to the organs, first forms round them a kind of atmosphere, and contributes to defend them from diseases of the adjoining parts. It also limits their extent and configuration, by furnishing an envelope even to their most minute particles. From this tissue is exhaled a serous fluid,* abounding with albumen, which continually lubricates it, and serves to facilitate the movements of the adjoining parts. This fluid is not very abundant, and appears in the form of vapour, when the lubricated tissue is exposed in the living animal. The continual absorption of this tissue is balanced by its exhalation. It is remarkable that its quantity is in the inverse proportion to that of the fat in different parts.†

It has been remarked that the cellular tissue is easily penetrated by moisture, and by fluids in contact with it. It also enters largely into the composition of the organs of absorption.

### MORBID ANATOMY.

The cellular tissue is the seat of many accidental productions, such as polypi, scars, fungous growths, &c. and this proves its great plastic, or productive, power. We shall say a few words on this subject.

When a solution of continuity cannot be immediately re-

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* Many anatomists suppose that it exerts a chemical action on this product.

† The fatty fluid, which has been hitherto placed under the same head as the serous, in the history of the cellular tissue, appears to be deposited in a particular tissue. This will be described separately, as a modification of the one under examination. This distinction appears well founded, and we shall occupy a separate article on the adipous, or fatty, tissue.

united, the exposed surface becomes inflamed, and is soon afterwards covered with red granulations. These have been called *fleshy sprouts* or excrescences *(bourgeons charnus)*, though very improperly, as they result from a developement of inflamed cellular tissue, and not from a regeneration of flesh, as Galen said. These vegetations produce a purulent fluid, they subside after different periods of time, and become contracted; while this takes place, the secreted matter becomes thicker, and finally organized under the form of a pellicle, which is amalgamated with the adjoining epidermis; under this, the diminished granulations are converted into a wrinkled tissue, very analogous to the chorion of the skin. This tissue then loses its reddish tint, and becomes generally whiter than the integuments; this is called a cicatrix, or scar. These phenomena take place from the circumference to the centre of the wound, the edges of which approach the latter, from the contraction of the granulations. Scars, in this manner, occupy less space than the wounds which caused them. After the immediate union of solutions of continuity, neither fleshy growths nor suppuration are visible. The cicatrix is formed by effusion, between the lips of the wound, of an organizable matter, which first acquires more density than the cellular tissue, and afterwards is confounded with it.

The cellular tissue is frequently distended by an accumulation of the serosity which lubricates it. This affection is called *Œdema* or dropsy, when it is local, and *Anasarca*, when it occupies the whole system. It is generally connected with the existence of some chronic affection of one of the principal viscera, or with some impediment in the circulation. The most depending parts of the body are the ordinary seats

of œdema. The extremities of the superior limbs are sometimes affected by it in diseases of the heart. The serosity, which is effused into the cellular tissue, quits the parts where it is found, if the depending position be changed; affording another proof of the permeability of this tissue, and of the pre-existence of its areolæ. Air sometimes penetrates into this tissue after wounds of the air passages. Gas also, in some instances, is disengaged in it: this kind of infiltration is called *Emphysema*. Inflammation frequently takes place in this tissue, called *Phlegmon:* it may be subdued before any alteration takes place (resolution); and this renders it, in general, very brittle as long as it lasts. Acute phlegmon easily terminates by suppuration, that is, by the secretion of a white, creamy, inodorous liquid (pus). This is first disseminated through the areolæ where it is formed, it is then collected into one focus (abscess), and always has a tendency to find its way to the surface. This soon takes place when the inflammation is intense, and when the situation of the abscess is favourably situated: in that case, we often see portions of the cellular tissue issue with the pus. If the disease be not very active, the walls of the abscess are covered by a membrane, which is composed of condensed cellular tissue, and has some analogy with the mucous membranes. When the pus has been evacuated, the walls of the abscess become united, and the cavity is obliterated; or else there continues to issue a purulent matter, and the passage which it takes to arrive externally is also covered by a mucous membrane, and is thus converted into a *fistula*. Abscesses are sometimes crossed by bands and species of partitions, which are remains of the cellular tissues of the cavity. The gangrenous sloughs, which are sometimes

produced by an acute phlegmon, are soft and greyish. Those sores filled with matter, and which give rise to certain phlegmonous tumours, as the boil and carbuncle, are attributable to a sort of strangulation, which the inflamed cellular tissue has undergone. When inflammation passes into the chronic state, it is often followed by the exhalation and effusion of a concresible matter in the cellular tissue; and this gives rise to the disease called *white swelling.* It is this which constitutes the granulations which we often see in the subserous and submucous cellular layers. This is the pathological condition of the Elephantiasis of Barbadoes.

*Induration of the cellular tissue of new-born infants,* called *Sclerema* by M. Chaussier, is a disease observed almost exclusively during the first months of life. It is characterized by a considerable consistence and firmness of this tissue, particularly in the subcutaneous layer. On making an incision into it, there issues a yellowish fluid, which Meckel considers to be a mixture of fat and serosity. Audry attributed this affection to a suppression of the cutaneous perspiration, while others have given it a syphilitic origin. The researches of Breschet prove, that it is accompanied by a continuation of the foramen Ovale, and, consequently, with a remarkable inperfection in the respiration.

When foreign bodies are introduced into the cellular system, they excite an inflammation around them, and are generally ejected by suppuration (inflammation eliminatoire). Sometimes they have a long passage to traverse: instances have been known, when they have been deposited in the alimentary canal, that they have pierced its coats, and have been carried into every part of the body, without giving rise to

any serious accidents.* The cellular tissue is sometimes condensed round them, and thus provides them with a membranous envelope, or *cyst*. (Vide Serous System.) The blood, the product of the secretions and the excrements, is sometimes effused into the cellular tissue, and is then considered as a foreign body. The blood thus dispersed through the areolæ of this tissue, is called *Ecchymosis*, and is often collected into one spot, previously to its being reabsorbed. It is then reduced to a clot, which is soon afterwards enveloped in a serous cyst, and is more or less promptly absorbed by it. Secreted fluids, after effusion, are soon returned into the circulation; but the excretions, when effused into the cellular membrane, are very often followed by fatal inflammations; while those produced by the two former kinds are generally slight. Certain organized beings, particularly hydatids, are sometimes met with in the cellular tissue. The *filaria medinensis* (the filaria dracunculus of Bremser) or Dragonneau, and the *furia infernalis*, pierce the skin and are found in this tissue.

* This was the case with a woman who had swallowed needles, and who died, some years since, in the hospital of St. Louis. On examining her body, many hundreds of these little instruments were found in the cellular tissue, in different parts of her body.

*Works referred to on this Subject.*

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## SECTION II.

### THE ADIPOUS TISSUE.

SYNON: Cellulo-adipous Tissue, fatty membrane; Adipous net, Tunic.

All anatomists do not recognize the vesicular tissue, in which the fat is deposited. Malpighi, Morgagni particularly W. Hunter, and more lately Proschaska, Mascagni, Chaussier, and Béclard, have described this tissue as distinct from the preceding; but Bichat, who has adopted Haller's ideas on this subject, has declared that the fat, as well as the serosity, is exhaled and deposited in the areolæ of the cellular tissue. Very lately J. F. Meckel affirmed that the adipous fluid is enclosed in small, round, and regular, vesicles, formed accidentally by that species of gluten, which constitutes, in his idea, the areolar tissue. The facts, on which depends the distinction between the latter and the adipous tissue, have been but lately established by Béclard, and appear to us too conclusive to require discussion here.

*Definition.—The adipous, or fatty tissue,* is formed of very small vesicles, united into masses of various sizes, and filled with a fatty matter.

*Situation.*—It abounds externally under the integuments of the face, neck, anterior part of the chest, abdomen, buttocks, palms of the hands, and soles of the feet. It is an accumulation of a large quantity of this tissue, which causes that enormous developement on the posterior parts of Hottentot women, on the tails of the Barbary sheep, and the eminences which are placed on the backs of certain animals, in camels, for example. There is also a large quantity found in the interstitial spaces between the muscles. Internally, the adipous tissue is found round the great vessels, on the surface of the heart, round the kidneys, between the folds of the mesentery and the epiploon. It also exists, under the name of *the marrow,* in bones. In these it occupies the areolæ of their spongy and reticulated portion, the very small interstices of their compact portion, and the medullary canal of the long bones. The adipous vesicles are here deposited in the areolæ of a cellulo-vascular membrane, which we shall describe in our history of the osseous system. The interior of the cranium, of the eye, eyelids, penis and scrotum, the submucous cellular tissue, the lungs, &c. are in general deprived of fat. Persons of moderate fatness do not possess fat in those parts where its presence might impede their functions.

*Difference of situation and quantity, according to the age and sex.*—The fœtus does not present before the fifth month, and then only under the skin, any isolated adipous vesicles. As it approaches the full period, the fatty tissue becomes more abundant, is seen in less superficial parts, and lastly in the visceral cavities. It is more considerable in quantity at its full growth than at any other period of life, and is more abundant in women than in men. In old age, it is

almost exclusively found round the thoracic and abdominal viscera.

*Form.*—The adipous tissue is sometimes found under the form of layers, of various densities (as the subcutaneous), sometimes under the form of cushions (in the orbits), and, at other times, in the form of bands or folds (in the omentum), &c.

*Structure.*—On examining the texture of a portion of the fatty tissue, we find it first composed of small oblong masses, between which creep blood vessels. These masses are formed of an assemblage of miliary grains; these again are made up by the accumulation of a multitude of small vesicles, which are closed on every side, round, rather compressed, transparent, visible only by the microscope, and whose walls are, in all probability, but a modification of the cellular tissue. These walls are not distinct, and yet we can have no doubt of their existence; for, 1st. when we expose a portion of adipous tissue to a temperature sufficient to liquify the fat, it does not run, which it ought, were it free in the areolæ of the cellular tissue: 2nd. Though it is fluid during life, it never descends from its weight, however abundant it may be, towards the most depending parts: 3rd. It is not dispersed through every part of the body, as the cellular tissue is, and this at least would appear to indicate a difference of organization. The adipous vesicles are united by a very fine cellular tissue; they receive blood vessels, which can be easily injected. The blood vessels first creep between the small oblong masses, and these form a net-work, which transmit to each grain a pedicle, composed of an artery and vein. From these again, small divisions, or pedicelli, are sent to each vesicle, and appear to terminate in them. We

know very little of the lymphatic vessels of this tissue, and we are still ignorant whether it possesses nerves.

*Physical and chemical properties.*—The extreme tenuity of the fatty vesicles limits our knowledge of their properties to those which result from the presence of the fluid enclosed in the adipous tissue; and of this fluid we shall speak presently.

*Vital properties.*—The adipous tissue possesses no sensibility in its healthy state; and, when inflamed, it cannot be distinguished from that of the surrounding cellular tissue. Its contractility is very obscure, but it most probably participates in that of the cellular tissue.

*Functions.*—The adipous vesicles contain the substance, called the fat, which is fluid during life. This substance varies in colour, consistence, and odour, according to the species of animal examined. The fat of man is yellowish, inodorous, of a sweet and very mild taste, lighter than water, is fusible at 60° Faht. (that of the bones is at a lower degree), insoluble in water, is scarcely soluble in cold alcohol, but very easily in boiling alcohol. At an elevated temperature, fat is decomposed into hydrogen, oxygen, and carbon, variously combined together, and does not yield an atom of azote. Its combination with the oxygen of the air gives the sebacic acid. By distillation, it furnishes acetic acid, and carburetted hydrogen gas. When treated with alkalis, we obtain margaric and oleacic acids, and a sweet principle (M. Chevreul). These last products do not exist in it naturally, but result from new combinations of the elements of the fat. On the other hand, M. Chevreul has shewn that this substance is composed of two immediate principles, namely: *Elaine,* which is soluble in alcohol, and

fluid at 48° Faht.; and *Stearine,* which is much less soluble in alcohol, and is fluid only at above 114° Faht. The degree of fusibility of each species of fat depends on the proportions in which these two substances are found combined. Our ideas on the secretion of fat, and of the organic agents which produce it, can only rest on hypothesis. Malpighi supposed at one time that the vessels of the adipous tissue were supplied with a secreting apparatus; but this great anatomist soon abandoned that idea, which was totally without foundation, and upon which others have since formed opinions. Riegel said that the glands, and particularly the renal capsules, were the secretory organs of the fat. Haller formed a gratuitous supposition that it flowed with the blood; that, from its lightness, it surrounded the column of this fluid, and that it escaped through the coats of its vessels. But at this time we can form no other idea of the fat, than that it is the result of an exhalation, seated within the parietes of the adipous vesicles. This function sometimes presents a remarkable activity, particularly after prolonged abstinence; repose of all our organs, the use of farinaceous food, and castration, favour it much. The exhalation is here balanced, as elsewhere, by absorption, as is particularly remarked in chronic diseases of the principal viscera, in long and abundant suppurations, discharges, &c.

The fat is also of use in preserving certain parts from the inconveniences of the constant pressure to which they are subjected, as in the soles of the feet, on the buttocks, &c. As it is a bad conductor of caloric, it serves, in some measure, to prevent a diminution of it; but it appears particularly destined to nutrition, that is, it may be regarded as a nutriment in reserve. This is evident in animals who sleep

during the whole winter. The fat of bones appears to have no other destined use than that of the other organs. There is no foundation for the assertion that it renders the bones less fragile (Haller), that it assists in their consolidation after fracture (Haller), in their nutrition, in lubricating the articulating surfaces, &c.

### MORBID ANATOMY.

*Obesity, fatness, or Polysarcia*, may be considered as a morbid condition of the adipous tissue. This affection impedes the functions of other organs. When this extraordinary developement is local, it receives the name of *Lipoma*. Sometimes this species of tumour is surrounded by a cyst: it presents in general one or more pedicles. Some of these lipomata or tumours has been known to weigh at least 30 or 40 lbs. Their form is an irregular spheroid, and their usual seat is under the skin. They are also met with in the thoracic and abdominal cavities, particularly in the omentum: when they pass out by the inguinal ring, &c. they are called fatty herniæ. Inflammation, of lipomata and of the adipous tissue in general, terminate most frequently in gangrene, and this morbid condition may then degenerate into schirrous and carcinomatous affections. The adipous tissue is sometimes developed in the ovaria, in the submucous cellular tissue, and in other parts where it is not so usually seen. The muscles, and some other organs, are subject to fatty degeneration, but Béclard believes that this condition is only remarkable in the former. We shall have occasion to revert to the subject when we treat of the parts in which they are found. Traumatic inflammation of the adipous tissue causes the evacuation of the vesicles and the disappearance of

fat from the surface of the wound, which is soon covered with cellulo-vascular granulations (*bourgeons*), and is cicatrized in the manner we have described in the preceding section.

In infiltrations of the cellular tissue, the serosity penetrates between the adipous grains and vesicles, and separates them from each other, thus affording us an opportunity of observing them with greater facility.

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# CHAP. II.

# VASCULAR SYSTEM.

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## SECTION I.

### GENERAL CONSIDERATIONS.

*Definition.*—The vascular system is composed of an assemblage of membranous tubes (vessels), united together in such a manner as to present a ramified appearance, like trees, and penetrated by the fluids, which are destined for nutrition and secretion.

*Division.*—This system presents three kinds of vessels: two of them carry the blood, namely, the arteries and veins; the third comprises the lymphatic vessels, which carry the lymph and chyle. These fluids are white; the former is secreted from all the organs, and the latter is the product of digestion, and is absorbed from the inner surface of the intestines.

The arteries and veins, when considered in relation with the heart, and with the blood which passes through them, have been divided into those of the pulmonary, and into those of the general system. But Bichat, struck with the analogy of their functions more than with their anatomical characters, has classed together those vessels which correspond to the same side of the heart, and has drawn some very beautiful results from his division of the sanguineous system into that of red and that of black blood.

*General conformation.*—The three divisions of the vascular system form an uninterrupted whole, which is called the

*circulatory apparatus;* for such is its disposition, that the contained liquids return to the same point from whence they issued. We shall now proceed to give a general idea of them.

An artery, the aorta, after leaving the left cavities of the heart, carries, by means of its numerous ramifications, red blood into every part of the body. From these parts arise a multitude of small vessels, which form continuations of the extreme divisions of the arteries. These veins become successively reunited, and terminate, after receiving the lymphatic vessels, in two great trunks (venæ cavæ), and one much smaller (the coronary vein), and pour blood, nearly black, into the right cavities of the heart. From these latter arise the pulmonary artery, whose divisions are multiplied innumerably, and distribute this black blood through the lungs, where the inspired air imparts to this fluid its red colour, at the time that the minute ramifications of the arteries terminate in the veins. These latter, by successive reunion, form branches and trunks, and terminate by the pulmonary vein in the left cavities of the heart, from whence we lately commenced.

We have already said that the heart was the centre of union of the great vascular trunks; and as these get further from the heart, they divide into branches, twigs, and ramifications, becoming more and more minute. Each vessel preserves the same diameter as far as the point at which it is given off. Their form is, therefore, cylindrical. It is thus we see the spermatic artery pass through a long distance without any alteration in its dimensions. If, on the one hand, every ramification is smaller than the branch from which it arises, on the other hand, the total of their calibres

is greater than its trunk ; so that the vascular system is actually increased in proportion to its distance from the heart. It is in this sense that anatomists have, in imagination, compared this system to a cone, the apex of which is the heart, and the extremities of the smallest vessels its base. The symmetry of the vascular is by no means equal to that of the nervous system. The heart and great trunks are not placed exactly on the median line, and the corresponding vessels of either side do not all arise from it in a regular manner. Thus the trunk, or arteria innominata, gives rise, on the right side, to the subclavian and carotid arteries ; but on the left, they arise separately from the aorta. In general, however, the symmetry of the vessels exists in parts, which themselves present a symmetrical disposition.

*Varieties of vascularity in organs.*—Organs do not present the same degree of vascularity : the most furnished, 1st, *with blood-vessels*, are, the lungs, the integumentary system, the pia mater and choroid membranes, the glands, follicles, the cortical substance of the brain, the nervous ganglia, the muscles, and the glandiform bodies. 2nd, *with lymphatic* vessels are the lymphatic glands, the serous membranes, the cellular tissue, and glandiform bodies. Vessels have not yet been discovered in the cartilages, nor in the appendages of the skin. The single organs, which are separated by the median line into two lateral portions, receive the same number of vessels on each side. There are very few organs which do not receive many vessels of each kind ; such are, however, the eye, testicles, and kidneys. When examined in those parts to which they are distributed, and from whence they are given off, vessels present a variety of divisions, which frequently anastomose between each other.

The smallest vessels called capillaries (from *capilli*, hair), though their name affords but a feeble idea of their tenuity, are dispersed through every part of their body, as is proved by microscopical examinations and by injections. The most minute ramifications are found more especially on the surface of the body; the branches are placed much deeper, and are lodged in the abundant cellular tissue which fills the great interstices of our organs, particularly on the side of flexion; and the trunks are found exclusively in the thoracic and abdominal cavities.

*Mode of division.*—The manner of division in vessels varies much. Sometimes it consists in a bifurcation, each branch of which is equal to the other; it is thus that the aorta terminates in the abdomen. But more generally a branch is detached from the trunk, which still continues on its course. In this case, there is no constant proportion between the volume of the two. We see, for instance, small arteries arise from the aorta, as the spermatic, &c. The origin of vessels is in general very near the point where they terminate, and it is very rare to observe them pass for some distance without giving off some divisions. The spermatic artery is one of a small number, which makes an exception to this rule.

Vessels send off their branches at very various angles, but they are generally acute, particularly in the limbs. The divisions, however, of the great trunks, present many right angles, and the superior intercostal arteries and recurrents of the extremities are detached at very obtuse angles.

*Modes of communication.*—Vessels of each species communicate together, not only because they arise from ramifications of the same trunks, but in consequence of the con-

nexions, called anastomoses, which we shall describe as we proceed from the most frequent to the more rare.

Two vessels meet, and uniting form an arch, the convexity of which furnishes some very small twigs; as in the neighbourhood of the articulations, intestinal canal, hand, foot, &c. At other times, the communication takes place by means of an intermediate branch, as in the anterior cerebral arteries; the vena cava with the umbilical, by the canalis venosus, &c. And, lastly, we see two vessels of equal volume, verging to the same point, confounded so as to form only one, which follows a middle direction to the two first: it is in this manner the two vertebral arteries form the basilic. Each variety of anastomosis may be referred finally to one of the three species we have just described. They are the more frequent, as the vessels are more minute, multiplied, and superficial. The lymphatics present more than the veins, and the latter more than arteries. Anastomoses serve to facilitate the course of the fluids, and to re-establish it by some collateral channel in those parts in which some principal vessel has been obliterated. It is by this means that we see the circulation properly continued, even after the contraction or obliteration of the largest branches has taken place.

*Surfaces.*—Vessels adhere by their external surface to the surrounding cellular tissue, which is condensed on their circumference, and forms for them a sheath. Their internal surface is smooth, and moistened by a fluid, the existence of which many authors have disputed. It is placed in contact with the fluid which passes through the vessel, on which are seen some eminences, or spurs, corresponding to the points where the branches form angles, as they separate from their trunks.

*Structure.*—The parietes of vessels are formed of many cylindrical membranes, placed one over another. Their structure and other characters differ according to the species of vessels under examination. We shall, therefore, describe them by giving a particular history of each variety. The thickness of the parietes is proportionably more considerable as the calibre of the vessel is small. They receive very small twigs of blood vessels and lymphatics (vasa vasorum), which can be traced as far as their middle coat. The nervous twigs, which are distributed on them, form a kind of network on their surface. Some come from the cerebro-spinal centre (the arteries of the limbs from the head and neck); and others, which are the most numerous, belong to the system of the trisplanchnic (namely, those of the great trunks, and arteries in general which support nutrition).

*Physical and vital properties.*—The physical and vital properties of vessels differ, as well as their functions, too much, according to the species, to allow us to speak of them in this place.

*Their mode of developement, and varieties according to age.*—The mode of developement of the vascular system has hitherto defied examination, both in man and in mammalia. It has only been observed in the eggs of birds, and the following are the remarks that result from it: The vitelline sac or envelope, which appears to correspond with the umbilical vesicle of the mammalia, first presents certain small isolated fissures, filled with a clear and thin fluid. The number of these fissures increases, and, by their union, appear like a little tree, the trunk of which soon becomes perceptible This is the omphalo-mesenteric vein, which, at this epoch, contains red blood. It passes from below up-

wards on the anterior surface of the embryo, then becomes dilated and forms the heart. The arteries afterwards appear, and then the veins. We have every reason to believe that in the embryo of mammiferous animals the growth takes place in this manner: that the umbilical vein is first formed, and that the developement of the arteries of the body precede that of their corresponding veins. In a word, that the order of the appearance of vessels is that of the production of the fluid which they contain. These organs are at first merely hollow canals in the ambiant substance, which is gradually condensed, and gives them distinct parietes. They acquire their peculiar texture in a very slow and gradual manner.

In old age, the parietes of vessels are very dense, particularly in the arteries which are also very fragile. The number of vessels is much more considerable during the fœtal life. In fact, at this period, many branches are found which become obliterated after birth; such are the umbilical vessels, the canalis venosus, and arteriosus.

### MORBID ANATOMY.

Anomalies in the origin, situation, and form of the vascular system, are very frequent. We shall have occasion to speak of some of them when we treat of each individual order of vessels.

In newly formed tissues, as in cicatrices, in adhesions, and in pseudo membranes, we observe vessels which are at first developed singly, as those of the umbilical vesicle, but which afterwards communicate with those of the contiguous parts.

The pathological anatomy of vessels presents too much variety in each species to occupy us now; we shall therefore recur to it in the following sections.

## SECTION II.

### OF THE ARTERIES.

*Definition.*—Arteries are vessels which carry the blood from the heart to the various organs.

*Division.*—There are two arterial trees; the one, pulmonic, the other, general: the former contains black, the latter red, blood.*

*General disposition.*—The arterial system consists, at its origin, of two trunks, which arise from each ventricle of the heart. One of these, after being bifurcated, sends off to each lung a branch, which is there ramified; while the other is carried first towards the superior part of the thorax and gives off large branches, which go to the neck, head, and superior extremities; it is afterwards bent back, descends along the left and anterior side of the bodies of the vertebræ, gives many branches to the viscera of the abdomen, and is finally divided into two secondary trunks. These again furnish divisions to the pelvic organs, which go to ramify among the abdominal viscera.

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* This difference in the colour of the blood of the two arterial systems is not the only one between them, as we shall see hereafter.

Arteries, after a certain number of divisions (twenty, according to Haller and Bichât), terminate in the capillary system, where they are continued with the roots of the veins.*

*Situation.*—The situation of arteries is generally deeper than that of veins and lymphatic vessels.

*Form and diameter.*—Their form is more constantly cylindrical than that of the other species, and their diameter, which is generally smaller than that of their corresponding veins, becomes gradually diminished in proportion to their distance from the heart; a fact, not observable in the two other orders of vessels.

*Relative number.*—The number of the arteries is very much inferior to that of the other vessels; thus each arterial division of a certain calibre is very nearly equal to two veins and ten lymphatic vessels. This difference does not exist between the pulmonary arteries and veins, but relates only to those of the general system.

*Course.*—In their course, the great arterial trunks follow nearly a straight direction. The arch of the aorta, however, and the internal carotid, in the interior of the bony canal through which it enters the cranium, make an exception to this rule. The smaller arterial ramifications are generally more tortuous than the veins.

*Anastomoses.*—The anastomotic communications of arteries are more rare than those of the other vessels, but less so than has been asserted. They are particularly so between arteries of large calibre. The canalis arteriosus furnishes a communication of this kind only before birth, between the

* Some are still visible after their conversion from efferent into afferent vessels.

pulmonary vein and aorta. Anastomoses, however, are sufficiently numerous in the arterial system, to establish the circulation by collateral passages after ligatures of the great trunks, such as of the abdominal aorta, iliacs, carotids, &c.

*Surface.*—The external surface of arteries is surrounded by a sheath, with which it is rather loosely united, and which is formed by the condensation of the surrounding cellular tissue. This envelope is particularly firm in those parts which are subservient to locomotion. In the splanchnic cavities, it is supplied in many parts by folds of serous membrane. In this manner, the pericardium is slightly prolonged over the origin of the arterial and venous trunks. The internal surface is smooth; some have said that it is lubricated by a fluid, the existence of which has not been ascertained. It presents, at the entrance of the ventricles, some valves, which we shall presently describe, and which are the only ones found in the arterial system.

The thickness of the parietes of the arteries, is, *ceteris paribus*, in the inverse ratio of their calibre *; thus aneurisms are less frequent in their branches than in their trunks.

*Structure.* — Three cylindrical membranes, placed one over the other, form their parietes.

1st. *The external*, which is formed by the cellular tissue, presents a closer texture on the side corresponding to the middle membrane, and is looser externally. This tunic, the most extensible and most elastic of the three, is the only one that is not lacerated, when an artery is tied.

2nd. *The middle, or fibrous, or proper membrane of the*

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* The calibre, therefore, is smaller, in proportion to the external diameter, in the smaller, than in the greater, arteries.

*arteries*, is formed by a peculiar yellow, very elastic, tissue, which exists in the arterial passages, and composes the ligaments of the vertebræ. (See the account of the yellow, fibrous, tissue). This tunic is composed of fibres, nearly circular, whose axis is not precisely parallel with that of the vessel. These are disposed in layers, which are easily separable, and have thus given rise to the opinion of there being different membranes. These fibres are firm and very elastic, when considered in reference to their length, which corresponds to the circumference of the artery; their firmness causes the latter to remain open, when empty. The middle tunic is more intimately connected with the external, than with the internal, coat. It arises at about a line from the ventricular orifices by three semilunar festoons, whose summits, though directed towards the latter, are separated from them by a fibrous ring.

3rd. *The internal*, called also *the common membrane*, from its being continued into the cavities of the heart, is thicker in arteries which carry red blood, than in those which carry black, and presents no appearance of fibres. It is whitish, transparent, thin, particularly fragile, smooth, and close, on its inner surface, and adheres externally to the fibrous tunic. At the entrance of each ventricle, it forms three folds, which adhere to the circumference of the little tongues, furnished by the middle tunic in this place. The free edges of the latter follow the course of the blood, and are furnished at the centre with small cartilaginous knobs*. These folds are

* These bodies serve to fill up the space which would be left between the free edges of the valves when they are united to close the orifices of the vessels.

called the *sygmoid* or *semi-lunar* valves, and prevent the return of the blood from the artery into the ventricle.

We see, from the preceding observations, that the arteries are attached to the heart by the continuation of their internal membrane into its cavities, where they are confounded with those of the venous trunks. The heart, in this manner, which is composed, in man, of two distinct lateral cavities, after birth, must be considered as a double portion of the vascular system, which does not differ from the others, only in having its external envelopes composed of interlaced muscular fibres, instead of being fibrous and cellular.

Arteries receive vessels of the three orders and nerves. These latter are larger and more numerous in those which carry black, than in those which convey red blood, and also proportionally in the smaller, than in the greater, divisions. They are ganglionic in the splanchnic cavities and in the neck, and cephalic in the extremities.

*Physical characters and properties.*—Arteries are less dense, but thicker, than veins. They are less resisting than the latter, and possess a much greater elasticity. This is owing to their fibrous tunic, which is, however, very fragile. This property of their tissue is more considerable with regard to their length than their circumference, and in the larger than in the smaller arteries.

*Vital properties.*—The sensibility of arteries is very obscure. Their property of vital contraction has been denied by Haller, Bichat, Nysten, and, more lately, by Magendie, who have asserted that these vessels gave no sign of irritability under the influence of mechanical and chemical agents, nor under that of Galvanism. But the facts published by Zimmermann, Verschuir, Soemmering, Hunter, Hast-

ings, Parry, Giulio, Rossi, &c. prove the want of precision of those who have denied the contractility of arteries. Physiologists of the present day generally think: 1st. that the arteries do contract; 2nd. that this action is the more observable in them, as their calibre is smaller and their elasticity less.

The contractility of the arteries is evident by their beating, or pulsation, which constitutes what is called *the pulse*, and this phenomenon results not only from an entire movement or displacement of these vessels by the impetus of the blood pushed into them by the ventricles, but also from the expansion and contraction of their parietes, in consequence of the intermitting afflux of this fluid.* Each of these species of motion have in their turn been considered as the exclusive cause of the pulsation; but it has been shown that they both assist in it, and that the former predominates in the great trunks, and the latter in the branches and ramifications. The number of the pulsations of the arteries corresponds in general to that of the contractions of the heart, and it is on this account that the pulse holds so important a rank amongst the symptoms of diseases. It shews us, by *its fulness*, *its developement*, *its frequency*, *its quickness*, *its regularity*, *its equality*, as well as also by the qualities opposed to these, and by many others, its peculiar state, and degree of intensity of diseases both of the heart and of other organs, whose disorders re-act on the circulation, which may be the seat itself of disease. In some inflammations (parti-

* Attentive observation shews in each pulsation a prolongation together with dilatation, followed by a shortening with contraction of the arteries.

cularly the phlegmonous), the arterial pulsations of the diseased part are accelerated, independent of the action of the ventricles. We also see, in paralytic patients, that the pulse is more feeble in the limbs which are deprived of motion than in the others; affording another proof of the contractility of the arteries.

*Functions.*—The arteries distribute through every part of the body the blood which they receive from the heart. The course of this fluid is not uniform throughout, for each ventricular contraction impresses on its mass an accelerated motion, which is easily observable when one of these vessels is cut. The blood is then seen to issue without interruption it is true, but in jets and jerks, which are isochronous, as well as the pulse, with the pulsations just mentioned.

When the collateral arteries of a great branch are called on to supply it in its functions, their calibre is considerably increased, which takes place, not only by a dilatation of their parietes, but also by an actual growth;* for these latter do not become thinner in proportion to their developement. On the other hand, the artery, which now ceases to give passage to the blood, retracts and terminates by being obliterated and changed into a cord. We cannot say here that this is the result of contractility, but a consequence of its inaction, one of the effects of which is to diminish the activity of nutrition.

*Varieties from age.*—Arteries are more developed in proportion as subjects are more young; they are also more supple during the first years of life, and they afterwards acquire those qualities by which we know them. In the decline of

* This increase sometimes takes place both in length and in width.

life these vessels lose their elasticity and become more and more fragile. Their ossification, at this period of life, may be considered as a normal condition, as one of the forms which their middle tunic must put on, for that is usually the seat of it. The parietes of the great trunks are thin and friable in old age, particularly those which carry red blood.

*Anomalies of origin.*—Bichat, and after him, Meckel and Béclard, have believed that the malformations of arteries were at least as frequent as those of the veins,* in proportion to their number and volume. Meckel counts ten congenital varieties in arteries, which arise from the arch of the aorta, while he knew but one anomaly of the superior vena cava. This author has made a similar remark with regard to the arteries and veins of the extremities.

### MORBID ANATOMY.

The arteries are subject to alterations of form without any lesion of their tissue. Thus their volume may be augmented, either throughout their length, as in parts which have been for some time inflamed,† or only in a portion of their extent. When the dilatation is local (the true aneurism of the ancients), it occupies sometimes the whole circumference of the vessel, sometimes (and that more frequently) a part only of the latter. Arteries are also subject to contractions, both general and partial. The former are more particularly remarkable in those parts in which vitality is languid; the latter are more common in the great trunks, and are some-

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* Haller, Soemmering, and Walthers, have professed the contrary.

† In this case, the thickness of the parietes correspond to the dilatation, as in the developement of the collateral branches.

times produced by a local change in the tissue of the artery. Inflammation of the arteries is distinguished by the redness* of their internal membrane, sometimes by a thickness of it, and by an albuminous exudation, which becomes organized, and occasions an adhesion between the parietes; when they are brought in contact by compression, or when ulcerations, gangrene, &c. partially destroy an artery. The internal membrane is most liable to inflammation; the external is the next in order; and this morbid condition renders it very fragile. Fungosities and vegetations are not unfrequent on the surface of the internal membrane, particularly in the neighbourhood of the small valves. We sometimes find, between this tunic and the middle one, encysted tubercular masses, which terminate in suppuration or ossification, and are liable to obstruct the vessel. Ossification, which is so frequent, as we have already observed, in old persons,† is also sometimes remarked in adults. But with it are often confounded those calcareous concretions which are formed between the middle and internal membranes, and which finally penetrate the latter and are visible in the interior of the artery.

In consequence of the local dilatation of a portion of the circumference of an artery, and very often also without this previous dilatation, the internal membranes become weakened by the impetus of the blood, or altered in their texture, and are lacerated. The cellular tunic is then distended in such a

* It is very doubtful whether this redness alone can be considered a sufficient proof of arteritis; it is, however, on this character alone that Frank has asserted that inflammatory fever depends on arterial inflammation.

† This is the usual cause of spontaneous gangrene, known by the name of *senile, or gangrene of old persons.*

manner as to form a tumour on the sides of the artery, and a communication is formed between them by an irregularly shaped opening, at the margin of which often float the remains of the lacerated membranes. This is *true aneurism*, one of the most serious diseases of the arteries, or even of the whole animal economy. The aneurismal cavity contains clots of blood; and its parietes are often lined with fibrous layers and false membranes. The tumour sometimes remains stationary after having attained a moderate size; but it more frequently increases and demands the assistance of art. We very rarely see it diminish and disappear in consequence of the spontaneous obliteration of the artery. It is by encouraging this object, which nature seldom effects, that art is able to cure aneurisms. This disease presents many varieties, which we cannot properly notice here. The trunks, and greater branches, particularly of the inferior limbs, are the usual seats of this complaint. *False aneurism* is a tumour formed by the effusion of the blood of an artery into the contiguous cellular tissue, whether it arise from a wound, or from the rupture of a cicatrix *(false primitive, false consecutive, aneurism)*.

When ligatures are applied to sound arteries, the internal membranes are divided, but the external one resists them; and the blood, being impeded, coagulates as far as the next branch in the direction of the heart. Inflammation supervenes, and terminates, at the end of forty-eight hours, by means of an albuminous exudation. Adhesion takes place between the parts in contact with each other, the tissues included in the ligature are divided, the latter falls and is ejected, the clot is absorbed, and, lastly, that part of the artery which it filled becomes obliterated.

In those cases where the external membranes are ruptured and the internal one alone uninjured, cicatrization still takes place by the exudation of an organizable matter, which increases the thickness of the parietes. At other times, the internal membrane is distended, and ruptured across the part where the others are divided, forming the *mixed internal aneurism.*

Jones and Béclard have instituted some very beautiful experiments on dogs, as relates to wounds of all the arterial membranes. The following are the results: 1st. A very delicate puncture was followed by a very feeble hemorrhage, by the formation of a clot, which plugged up the wound, and by the perfect cicatrization of it, leaving no mark. 2nd. All other wounds of arteries are fatal if the cellular sheath be destroyed; on the coutrary, if this does not take place: (*a*) a longitudinal wound is healed similarly to the simple puncture, but there remains a linear cicatrix; (*b*) a transverse wound, which embraces but a fourth of the circumference of the vessel, is capable of being healed; (*c*) a transverse wound of the half is followed by too great a separation of its margins to allow of cicatrization; it is, therefore, mortal; (*d*) a transverse wound of three-fourths may be healed if the retraction of the ends is sufficiently strong to complete the solution of continuity; (*e*) when the transverse wound is complete, the ends recede into the cellular sheath, and after a violent hemorrhage, syncope permits the formation of a clot, and cicatrization takes place. In man, the cure of wounds of arteries has hitherto appeared very difficult, and their cicatrices not very solid. Wounds, however, from fire-arms, and from the cautery, seldom bleed much, as the blood is retained by the scars, which are not

detached until after the obliteration of the artery. In lacerated wounds the arterial membranes are ruptured successively from the interior outwards, and the end of the vessel assumes a conical form. This, together with the retraction, consequent on excessive elongation of the vessels, opposes a sufficient obstacle to the hemorrhage, to allow the formation of a clot.

## SECTION III.

### OF THE CAPILLARY VESSELS.

*Definition.*—The capillary vessels, which we shall now describe, being only the extreme ramifications of arteries, and the primary radicles of veins, their history will naturally hold a place between that of the two divisions of the sanguiferous system.

Ramifications of vessels are called capillaries* from the moment that their tenuity conceals them from the naked eye. (The most delicate, which we can distinguish by the microscope, present the diameter of a single globule of blood, which is equal to about 1-150 of a millimetre, according to the experiments of M.M. Prévost and Dumas.)

*Division.*—The capillary vessels of the lungs form a separate system, which is distinguished from the general capillary system, 1st. because it occupies the other extremities of the two halves of the circle, traversed by the blood; 2nd. by its functions. In fact, in the general system, the afferent vessels carry the red, and the efferent the black, blood; while the contrary occurs in the capillaries of the lungs. We shall notice, further on, the physiological phenomena which belong to each of these two divisions. There is also another capillary system, the venous, in the liver, composed of the ultimate divisions of the vena portæ, and of the first ramifications of the superior hepatic veins.

*General conformation.*—The system of the capillary vessels

* From *capillus*, hair.

forms a large net work. These little vessels present on the one hand a successive decrease of their arterial ramifications in proportion as they subdivide, and, on the other, a corresponding increase in proportion as they reunite to form the first small veins.

*Situation.*—These vessels constitute together the most considerable portion of the vascular system; they are scattered throughout the whole body. Some have said latterly, that our organs were exclusively formed of capillaries: but this opinion has never yet been proved, nor refuted, since we possess no other means of determining the presence of these vessels than by injection, which does not demonstrate their existence in every part of the body. Inflammation, it is true, might assist us in clearing up this question, because it is accompanied by the appearance of red ramified streaks, in some tissues where the injected matter cannot penetrate (as in the cartilages, &c.); but it is very doubtful whether these present small vessels with distinct parietes, or merely simple canals accidentally hollowed into the substance of the inflamed organ. It remains for us then to examine the differences which the various tissues present with regard to the quantity of capillary vessels, discovered by injection. They may be divided in this manner: 1st. *into tissues, which cannot be injected;* these are the cellular tissue, the epidermoid and its appendages, and the cartilages; 2nd. *into tissues, which are injected with difficulty*, as, the white substance of the brain and nerves, the fibrous system (with the exception of the periosteum and dura mater), the serous membranes, and bones; and, 3rd. *into tissues, which can be easily injected;* these are composed of the adipose vesicles, of the cineritious substance of the brain, and of the neurilema, of the nervous

ganglia, of the muscles, but particularly those of the integuments, glands, and glandiform bodies. The lungs are more supplied with capillaries than any other organ.

*Modes of communication of the capillaries.*—The beautiful and accurate microscopic observations, made by Leuwenhoeck on the mesentery of frogs, the tails of fishes, and other transparent organs, have proved the continuity of the arterial and venous capillaries. The injected matter also penetrated with the greatest facility from the one into the other. The existence of a *parenchyma,* which the ancients and some moderns have supposed to be intermediate between the afferent and efferent vessels, has never been proved. We find in the reciprocal relations between the venous and arterial capillaries the three modes of communication, which we have mentioned in speaking of anastomoses in general. A capillary vessel seldom passes the length of two lines without being reunited to a contiguous vessel of one or other species; and this circumstance gives them their retiform appearance. It has not been satisfactorily ascertained whether the extreme arteries are continued with the radicles of lymphatic vessels; but, on the other hand, these latter frequently anastomose with the smaller veins.

*Structure.*—The parietes of capillary vessels can scarcely be distinguished from the substance of other organs, and we know not, therefore, any thing certain respecting their texture: we can only suppose that they are formed by the continuation of the internal membrane of the arteries and veins. The capillaries are interlaced with nervous filaments which are supplied from the cerebro-spinal centre as well as from the trisplanchnic, and from this assemblage result the papillæ of the skin and mucous membranes.

*Hypotheses of different authors upon the existence of serous vessels, &c.*—The supporters of the exclusively vascular composition of organs, among whom we find Boerhaave, have supposed, with many anatomists, such as Haller, Soemmering, Bichât, and Chaussier, that there exist vessels still more delicate than the last visible capillaries, of which they are a continuation, and that these small vessels only admitted the serous globules of the blood. Boerhaave even divided them into many orders, each more delicate than the other. That opinion rested, 1st. upon the impossibility of discovering how nutrition took place in organs which could not be injected, or at least with great difficulty; 2nd. upon the fact, that inflammation produces a red colour in parts which are white in their natural state. Bleuland even says that he once perceived white vessels which arose from the last arterial capillaries. We state in reply, 1st. that, as the miscroscope magnifies the last visible capillaries, we should be enabled to see others still more delicate, if they existed; 2nd. that we cannot appreciate by the colour the vascularity of an organ, as capillaries, which admit but one globule of blood, do not appear red; and we hence naturally conclude, that, if a colourless organ loses this appearance when it is inflamed, it is in a measure caused by the irritation, which has attracted a greater number of globules into its smaller capillary vessels; 3rd. that the inflammatory redness is often produced by the actual injection of the substance of the organs. In short, serous vessels have never been seen but once; and we cannot say that they do exist from that single experiment of Bleuland, the only one to this time performed.

Many anatomists have admitted the existence of extremely delicate vessels, whose office it is to transmit the materials

of nutrition and of exhalation, quite independently of the arteries: they also allow other capillaries equally fine, whose functions are to take up from every part of the body and to pour into the veins those exhaled fluids and organic particles which are destined to re-enter the circulating mass. The former are called *exhalant and nutritive vessels,* and the latter, *absorbent vessels;* but the existence of these intermediate agents has never been proved by experiment, any more than the presence of those terminations arising from capillary vessels, according to many others, who attribute to them the functions just mentioned. Besides, neither of these hypotheses elucidates the theory of absorption and exhalation; these latter take place more or less in every tissue of the body, and are the natural consequence of their hygrometric character.

*Physical and vital properties.*—The capillaries are very permeable. Their sensibility varies according to that of the organs in which they are situated. They are more contractile than the other portions of the vascular system.

*Functions.*—The motion of the blood in these small vessels is determined by the action of the heart, and by their own proper contractions. We have already pointed out the difference that exists between the general and the pulmonary capillary systems, inasmuch as regards the change of colour which the blood undergoes whilst passing through them. We shall now proceed a little further: the capillaries of the lungs expose the blood to the action of the atmospheric air, absorb its oxygen, and are the seat of an active exhalation, which issues from the body with the air expired. On the other hand, the smaller vessels, which arise from ramifications of the aorta, are charged with red blood,

and deposit in all the organs those parts of this fluid which are destined to their nourishment ; while again they lose, in other organs, those which are separated by simple exhalation, or by glandular secretion, and which are destined either to re-enter the vascular system (the recrementitious fluids), or to pass out of the body (the excrementitious fluids). They finally become capillaries, venous and carrying black blood, and absorb the recrementitious products of the above-mentioned functions and the residues of nutritious matter.

*Erectile tissue.*—This, we consider to be the proper place to mention a variety of the reticulated vascular system, which many authors, and more lately Béclard, have described separately under the name of *erectile tissue.* In some organs, such as the corpora cavernosa of the penis and clitoris, the lips of the vulva, the nipples, the circumference of the mouth, the papillæ of the integuments, the spleen, &c. we find that the extreme arterial ramifications are succeeded by fully developed roots of veins, which anastomose as frequently as the capillaries, and thus present the appearance of cells communicating together. This venous net-work receives many nerves, and is supported in the corpora cavernosa, spleen, &c. by an elastic fibrous tissue. When its sensibility is highly excited, it is subject to a determination of blood, which lasts only as long as the stimulus which caused it. This passing phenomenon is called erection. It is produced in the sexual organs by the desire and act of copulation, and in the papillæ of the tongue by gustation. Many causes, and among others the cold stage of intermittent fevers, give rise to it in the spleen.

## MORBID ANATOMY.

The calibre of the capillary vessels is much increased when they are required by means of their anastomoses to supply the functions of an obliterated vessel. They are generated in accidental tissues, as in pseudo-membranes, cicatrices, &c. In some parts, particularly under the skin, the capillaries are sometimes developed in such a manner as to form masses, which vary in their volume, configuration, and colour,—a developement very similar to vascular erectile net works, and susceptible, like them, of a transient effusion. This affection, called *Telangiectasie, aneurism of the extreme arteries* (a name which is far from being an exact term, since they are formed more from the venous, than arterial, radicles) is usually congenital, and is attributed by the vulgar to fancies of the mother during gestation. These irregular dilatations of the capillaries must be considered very analogous to those which constitute hemorrhoidal tumours.

As soon as the capillaries are irritated, blood flows into them, distends them, and communicates a more or less vivid red colour to the morbid tissue, the volume of which is capable of being sensibly increased. Sometimes, therefore, this fluid is exhaled and issues out, if the disposition of the part permits it (active hemorrhages); or it is effused into the contiguous tissues (spontaneous ecchymosis, apoplexy). At other times the redness and tumefaction, which we have just remarked, become more considerable; the affected organ in that case is usually painful, its heat is increased, and its arterial capillaries often present pulsations; this assemblage of phenomena characterises inflammation, or that morbid condition, the effects and results of which vary.

Sometimes it terminates without leaving any trace (as in resolution); it often modifies the exhalation, the results of which will be then: 1st. Sometimes a *serous liquid*, which at one time is effused and remains fluid, at another is coagulated to form false membranes, and at another is combined with the neighbouring cellular tissue and gives rise to a white induration and to all the degenerations which may result from the latter; 2nd. *pure blood*, which becomes intimately combined with the parietes of the capillary vessels and with the surrounding tissues, and produces the *red induration*, or *carnification*. This alteration is particularly met with in the lungs, being essentially vascular organs, in which it is called *hepatization*, from its assuming the appearance of the liver. 3rd. *Pus*, which is produced, in the manner we have already explained in describing the cellular tissue. Inflammation also frequently terminates in gangrene of the capillary vessels, and in those organs where it takes place. Their continued irritation produces fungous tumours, and the chief number of those diseases called organic.

## SECTION IV.

### OF THE VEINS.

*Definition.*—Veins are those vessels through which the blood is returned from the capillary systems to the auricles of the heart.

*Division.*—Besides the two trees, corresponding to those of the arterial system, the veins present us with a third, that of the *vena portæ.* The trunk of this is formed by the union of the veins of the digestive apparatus and spleen, and ramifies as an artery in the tissue of the liver. A superficial and a deep-seated arrangement may also be observed in the general venous system.

*General conformation.*—The veins, like the arteries, form, by their assemblage, a tree, of which the heart is the trunk.

*Situation, course, number, volume, capacity of the veins, compared to those of the arteries.*—This class of vessels is generally nearer the surface of the body than the arteries: of this the subcutaneous veins present a striking instance, and may be also remarked in the deeper seated, for example, the veins of the brain. The course of the veins is not tortuous like that of the arteries; this is an important circumstance, since it contributes to facilitate the passage of the blood, which traverses the greater number of these vessels against its own gravity. Each artery is usually accompanied by at least two veins, seldom by one only, and they pass with it through the same bony orifices, and the same interstices of

the soft parts.* We have already seen that the number of the veins far exceeds that of the arteries. Although this conclusion is just when applied to the aggregate number, yet, it is not so with regard to those blood vessels of particular organs, when taken singly. Thus the digestive canal, kidneys, testicles, &c. present an equal number of veins and arteries; the penis, clitoris, gall-bladder, and umbilical cord, have each two arteries to one vein; but, in the latter case, the superior calibre of the veins over that of the arteries compensates for inferiority of number. Arising from every part of the body by innumerable microscopic radicles, which are continuations of the extreme arteries,† the veins successively unite to form twigs, branches, and trunks; but the vein, which results from the union of two others is not in proportion so large, compared with each individually, as an artery, whose bifurcation is in proportion to one of its divisions. We see also veins, the calibre of which is not larger than that of the branches which they give off. This species of anomaly is more common in the most dependent parts, where the blood flows slowly and against its own gravity, and thus throws the greater impetus against the parietes of the veins, which are naturally very dilatable, in proportion as the extent of its columns, which separates them from the heart, is more considerable. The capacity of the

* In the lungs, intestines, &c. the small veins are folded over the arterial ramifications, which they accompany, and imitate for some time their manner of arborescence.

† The oozing on the internal surface of the intestines of matter injected into the veins has caused some physiologists to believe in the existence of venous radicles, having a free orifice. The reality of this anatomical fact is far from having been clearly ascertained.

venous tree exceeds that of the arterial, but in that relation which does not continue the same at every period of life. Thus, this superiority, which is scarcely perceptible during infancy, becomes more and more remarkable in the decline of life, and is extremely so in old age. This difference probably does not exist except in the general system of blood-vessels, as it is not observed in their pulmonary system.

*Anastomoses.*—The anastomoses of veins are very numerous; they are observable even between the greatest trunks. Thus the venæ cavæ communicate by the vena azygos. They are more multiplied in those parts where the course of the venous blood is less assisted, and in those where external agents present an impediment to it: thus, for example, the subcutaneous veins communicate so often together, that they form a species of net with large interstices*. There are also anastomoses between the two arrangements of veins, the superficial and deep-seated.

*Form.*—Veins are less regularly cylindrical than arteries, which materially assists in the facility with which they may be distended. Besides, their external surface presents, in certain parts, a species of contraction, corresponding with their internal folds, *or valves*, to be presently described.

*Structure.*—The parietes of veins, thinner than those of arteries, are composed, like them, of three cylindrical layers. We must except here the veins of the brain, or sinuses of the dura mater, which, until the time of Bichât, were considered to be formed entirely of this last envelope, but in which this great anatomist has shown the existence of an internal membrane.

* The spermatic veins and those of the pelvis equally present a retiform disposition.

1st. *The external or cellular layer* is less dense and solid than that of the arteries, and does not preserve its cylindrical shape, like them, when detached. It is pretty closely united to the middle membrane, into the substance of which it sends prolongations, which penetrate as far as the internal coat.

2nd. *The middle layer or membrane* is so very thin, that many skilful anatomists have doubted its existence. It is most distinct in those veins where the course of the blood is least easy (the subcutaneous), and in the large trunks. In this respect, that of the vena cava superior is more remarkable than that of the inferior. This tunic is of a loose texture, and is composed of soft, reddish, longitudinal fibres, which are evidently of a muscular nature towards the union of the great veins with the heart, and very extensible and difficult to be ruptured, as proved by the experiments of Witringham. The middle membrane appears to be wanting in the veins of bones, and is supplied by the dura mater in the cerebral sinuses. Fibrine is the predominant principle in them.

3rd. *The internal or common membrane* is thin, smooth, and polished, much more extensible and resisting than that of the arteries, and is of a filamentous texture: it is continued into the right side of the heart, and is the only membrane found in the veins of the bones and in the sinuses of the dura mater. This tunic forms a great number of curious folds, called *valves*, whose adherent margin is convex on the side of its origin from the vein, and whose free margin is straight, or slightly concave, in the direction of the heart. The valves are pressed against the internal surface of the vein by the blood in its passage to the heart; but, when

this fluid is forced, by any cause whatever, to retrograde, it escapes between the membranous folds and venous parietes, and separates their free edge from the latter. In this manner, from being parallel to the axis of the vessel, they now become nearly perpendicular to it, and form species of sacs; their cavities, being directed from the side of the heart, receive the blood and oppose its return. The valves are in general sufficiently large to stop up the cavity of the vessel; but at times they are merely the rudiments of valves, and reduced to slight eminences or transverse filaments, as we see in the crural vein and sinuses of the dura mater. They occasionally present certain anomalies; for example, a sloping of their free edges, a reticulated structure, &c. These anomalies are sometimes congenital, at other times, and this is more frequent, they are consecutive to the mechanical action exercised on them by the blood. Valves are generally met with in pairs, and placed diametrically opposite to each other. They are, however, single in veins of half a line, and under; sometimes also three or four are found, in the place of two. Valves do not exist in all the veins; they are found principally in those of the superficial series and in the most dependent parts of the body, and consequently in the inferior extremities: they are, moreover, more numerous and closer together, as they become smaller. The valves generally exist at the union of the small with larger branches, and of the latter with the trunks. The veins of the splanchnic cavities have none, but some of them (for example, the azygos) have them at their termination. The valves facilitate the return of the blood to the heart, by their opposition to its retrograde action; and they are placed in those parts where this fluid passes with the least facility

through the venous canals. Blood vessels and nervous filaments enter into the structure of veins, but in less number than in the arterial parietes, neither of which can we trace as far as the internal membrane.

*Physical characters and properties.*—Veins are whitish, semitransparent, very extensible, and susceptible of a considerable increase of volume: their elasticity is far inferior to that of the arteries. When empty, they do not preserve, like the latter, their calibre; but they subside and become flattened, unless their external surface adheres intimately to the substance of other organs.

*Vital properties.*—These vessels possess an obscure sensibility; their contractility is most apparent in the great trunks.

*Varieties from age.*—We have already seen that the capacity of the venous system was nearly equal to that of the arterial during infancy, but that it exceeded it in adults, and still more so in old persons. This difference arises from the circulation being weakened, in proportion as we proceed further from the period of our growth, when decomposition exceeds composition: these two causes, by accumulating the blood in the veins, increase the capacity, while they lessen the thickness, of their parietes. Senile ossification in these vessels is very rare.

*Functions.*—The veins return the blood to the heart from every part of the body, after this fluid has furnished the materials of secretion and nutrition, and is charged with the residues of this last function, as well as the new substances introduced by absorption into the economy. This course of the blood in the veins is proved: 1st. by the phenomena which accompany the presence of ligatures round these vessels, namely, their subsiding between the

heart and the ligature, and their distention between the latter and their ramifications; 2nd. by the direction of the valves; and 3rd. by microscopical observations. The course of the blood is equal and continuous in the veins. These vessels do not pulsate, if we except those cases in which, in consequence of some impediment to the respiration, or some organic disease of the heart, the contraction of the right auricle causes a part of the blood to flow back into the veins which they had just poured into it, while the other portion passes into the pulmonary ventricle.* The motion, impressed on the parietes of the veins by the fluid thus repulsed, is called the *Venous* pulse, and is only sensible in the great branches in the immediate neighbourhood of the heart. The progress of the blood in the veins is assisted by the following circumstances: 1st. The action of the aortic ventricle, which is here the medium of communication between the arterial and venous sanguiferous columns; 2nd. The peculiar action of the parietes of the veins; 3rd. The contractions of the contiguous muscles; 4th. An imbibition in, or inspiration of, the blood of the venæ cavæ by the right auricle, which is produced by the dilatation of the latter, as is still more evident at the time of that tendency to a vacuum, which the power of inspiration tends to effect in the cavity of the chest†. Lastly, the direction of the valves, and this cir-

* This reflux takes place in the natural state of the circulation, particularly during expiration; but it is not sufficiently considerable to excite notice by any external character.

† Dr. Barry has published a work on the causes of the circulation of the blood in the veins, in which he proves, by new experiments, that the blood only passes into them during inspiration: but he appears to us to have exaggerated the influence of the latter over the course of the

cumstance, that the blood passes from the smaller to the larger branches, and the great number of anastomoses, favour the course of this fluid in the vessels now examined. All these causes, however, of its progress towards the heart do not give it that impetus, which it receives from that organ in passing through the arteries; they do not completely neutralize the laws of gravity.*

Magendie and other modern physiologists have decided, after many experiments, that the veins absorb. This opinion, which was entertained by Galen and his successors down to T. Bartholinas, is so connected with that which refuses to the lymphatics any powers of absorbing other substances than the chyle, that we must refer to the history of the latter, to read the facts which have been advanced both for and against this doctrine.

### MORBID ANATOMY.

Veins are subject to dilatations, either in the whole, or in a part only, of their circumference, which are called *varices.* This affection is caused by a pressure of blood on the venous parietes, which is greater than the resistance they can oppose to it; consequently, they are more common wherever this fluid circulates against its own gravity, and, more particularly, where it meets with impediments to its course; thus the veins of the inferior extremities, particularly the subcuta-

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venous blood, inasmuch as he regards it as an essential cause, and similar to that of the dilatation of the auricles.

* According to M. de Blainville, the slowness of the motion of the blood in the veins, by retarding the passage of the elements of this fluid, favours those modifications which subject it to their mutual re-action. These modifications are not, as has been hitherto supposed, the result of an organic action of the vascular parietes.

neous and those in the pelvis, are very often the seat of them.* Varicose veins often present flexuosities, which indicate that there is, at the same time, an increase both in the calibre and length of the vessel.

The name of *aneurismal varix* is given to the dilatation of a vein, when it results from a communication between an artery and vein, which ordinarily arises from a wound, or from ulceration of the ossified parietes of the two vessels. The blood, in these cases, passes from the artery into the vein, and produces a sound similar to the bellows *(bruit de soufflet)*, which is very remarkable. When a false consecutive aneurism is formed in the intermediate tissue between these two injured vessels, it is called a *varicose aneurism.*

Contraction of the veins is much more rare than their dilatation. Its usual causes are, either an impediment from some cause or other to the passage of the blood in the vessel, or when chronic inflammation has either rendered its parietes thicker, or lined its internal surface with a plastic and membranous matter. The venæ cavæ and jugular veins have been obliterated without the circulation being interrupted. This alteration may be either general or local.

Solutions of continuity in veins are more easily healed than in arteries, pulsation being absent; but they do not cicatrize closely. This process takes place by the interposition of a plastic matter of new formation between the lips of the wound. When a transverse division of a vein is complete, the two ends of the vessel approximate in the same manner as in an artery, but the clot is smaller. The part, which ceases to transmit blood, is obliterated, and becomes

* Puchelt, the author of a German work upon the diseases of the veins, insists much on that general dilatation which, according to his opinion, performs a very important part in many diseases.

a cord. Inflammation and ulceration more easily follow wounds *of the veins* than those of the arteries. Ligatures do not divide the internal membrane of veins but indirectly, and that by the inflammation which they occasion.

Phlebitis, or inflammation of a vein, is a frequent disease, and is usually caused by: 1st. wounds of the vessels (it is not unfrequent after phlebotomy); 2nd. ligature of the veins; 3rd. ligature of the umbilical cord; 4th. inflammation of the circumjacent tissues; 5th. the varicose state of these vessels. The anatomical signs on dissection are: a more or less vivid redness of the internal membrane, accompanied, or not, by a thickening of the two other coats; purulent collections, which are formed on the external surface of the vein;* an effusion of a plastic matter on its internal surface. Inflammation of veins is generally propagated from the point first affected in the direction of the heart, and may be thus extended to some distance. Ossification of these vessels is very rare, and when it does occur, it appears like small round, inorganic concretions, of the size of a grain of millet seed, or a small pea, which are found more particularly in the veins of the pelvis, as well as in all those in which the course of the blood is most retarded. Those productions, called *phlebolitha*, sometimes adhere by a pedicle to the internal surface of veins; they are usually lodged in the dilatations of these vessels, and are covered by a very thin membrane. Adventitious growths are sometimes found on the internal surface of the veins. Their structure is made up of superlatent layers, and their composition appears to be frequently fibrinous.

* Hunter has seen a case of phlebitis give rise successively to a chain of abscesses, which opened outwardly on the surface of the injured vessel, and were followed by its obliteration.

## SECTION V.

### OF THE LYMPHATIC SYSTEM.

#### I. LYMPHATIC VESSELS.

*Definition.*—The name of lymphatics is given to those vessels which contain whitish fluids, and which arise from capillary radicles, sometimes in the substance of organs (see *Lymphatics, properly so called*), sometimes from the surface of the intestines (see *Chyliferous vessels*), and their union forms many trunks, which terminate in the general venous system.

*General conformation.*—The lymphatic system presents a form which is rather reticulated than arborescent. It is composed of a multitude of vessels, which communicate together by numerous ramifications, and terminate in two principal trunks.

*Situation.*—All organs, with the exception of the brain, spinal marrow, eye, internal ear, and placenta, contain lymphatic vessels. The latter, like the veins, present two series, a superficial and a deep-seated. This disposition exists both with regard to the extremities and parietes of the splanchnic cavities, and also in relation to the organs contained in the latter.

*Volume, number, and peculiar form.*—The volume of these vessels is inferior to that of the veins; and, in this respect, they present less variety than the latter between their greater and smaller branches, and they remain very minute, in-

dependent of their successive reunions. Those of the head are the smallest, those of the inferior extremities are rather larger, and those of the trunk and superior extremities are the most voluminous. Notwithstanding the minuteness of their size, the aggregate of these vessels presents a capacity equal to that of the venous tree; that is to say, their number is far superior to that of the veins; and, in fact, we reckon ten lymphatics to one venous or arterial trunk. Their form resembles that of small tubes, intersected by numerous nodosities, corresponding to the valves with which their internal surface is abundantly supplied.

*Origin, course, and termination.*—The origin of the lymphatic vessels has never been discovered; and we have only hypotheses and inconclusive facts to assist our enquiries on this subject. The continuation of their radicles with the arterial capillaries is still very doubtful, and cannot be proved by the single fact of the presence in the lymphatics of materials injected into the arteries. For this phenomenon, resting, as it does, on so few experiments, is extremely rare, when there is no rupture of the small arteries. Whatever the truth may be, lymphatics take their origin from the substance of organs, and, according to certain anatomists, from the surface of the tegumentary and serous membranes. The most delicate lymphatic radicles that we can discover, anastomose so frequently together, that they form perfect nets, so close in texture as to compose, in a measure, the covering of certain kinds of organs; such, for example, as the membranes above mentioned, &c. The most voluminous branches communicate together at more distant intervals; the anastomoses, however, of this order of vessels are always more numerous than those of the veins, and give

them, in every part, a reticulated appearance. In the course of these vessels are found lymphatic ganglia. These ganglia are penetrated by the former towards their termination, opposite to the thoracic duct, after having surrounded them with their numerous ramifications, called *afferent vessels*, while those which arise from the other extremity are called *efferent vessels;* and these become reunited, after quitting the ganglia, to form new branches. The greater number of the lymphatics in this manner traverse many ganglia; those of the mesentery are thus particularly situated. These little bodies follow the course of the lymphatics at very close intervals. On the other hand, the lymphatics of the extremities pass through an extent of one, and even of many feet, without meeting any. These vessels terminate in two principal trunks; one, *the thoracic duct*, commences by an enlargement, called the *reservoir of Picquet*, over the second lumbar vertebra, and terminates in the left subclavian vein, after having received the lymphatics of the inferior extremities, abdomen, of a great part of the thorax, of the left superior extremity, and of the left lateral half of the head and neck. The other trunk, called the *great right lymphatic vein*, is formed by the union of the lymphatics of the right superior extremity, of a part of the chest, and of the right lateral half of the head and neck. It terminates, after an extremely short passage, in the corresponding subclavian vein*. A great number of

* An anatomist of Florence, Dr. Rigolo Lippi, has recently discovered many other lymphatic trunks, one of which is rather large, and three rather less voluminous; they terminate in the inferior vena cava, at about the third lumbar vertebra; a fourth terminates in the common

lymphatics of every dimension terminate in contiguous veins. This fact, which is now well known, explains the rapidity of the passage of substances absorbed into the veins.

*Surfaces.*—The external surface is unequal, and adheres to the surrounding tissues: the internal is smooth, and furnished with numerous valves, to which we shall recur in the following paragraph.

*Structure.*—The parietes of lymphatic vessels are composed of two membranous layers, without reckoning a species of sheath, furnished to them by the cellular tissue, which is condensed around them. The external membrane is strong; its filamentous texture has given rise to the opinion that it is composed of muscular fibres; which has never been proved. The internal membrane is extremely thin and fragile, and forms the numerous valves which are found in the lymphatics. These folds are parallel in most of them, and annular in others (as in the liver). They are disposed in the same manner as in the veins, sometimes in pairs, sometimes singly. They are very numerous in the branches, and still more so in the ramifications, a few only are found in the trunks. A pair is found at the union of these latter with the subclavian veins. Lymphatics receive arterial and venous branches, as well as small vessels peculiar to them; nerves have not been discovered in them.

*Physical properties.*—Lymphatic vessels are more resisting than arteries and veins, in proportion to the thickness of their parietes. They are very extensible, and are suscep-

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iliac, and some others pass into the renal veins. (*Antologia*, Nov. 1824.) *Bullet. des Sciences Medicales*, published by M. le Baron Férussac, cahier de Dec. 1824.

tible of retraction after death, which proves their elasticity. On these properties depend the astonishing variations in size of the lymphatics, according as they are full or empty.

*Vital properties.*—The vital contractility of lymphatics has been sufficiently demonstrated; but their sensibility has only been proved by their inflammation.

*Varieties from age.*—We can say nothing positive on the variations which lymphatic vessels present at the different periods of life, both as to their capacity and the state of their parietes. Certain facts, and the pathological history of this system, would lead us to believe, that it is more developed and that it is more active, in infancy and youth, than later in life.

*Functions.*—The lymphatics absorb, in every organ, and on the surface of every membrane, those substances which are destined to enter into the blood; they carry them along, under the name of chyle (in the mesentery), and of lymph (in the rest of the body), and pour them at length into the venous system. We shall here present the alledged facts which have been brought forward to prove that the lymphatics do not absorb, and those also on which the contrary opinion is maintained.

The ancients, who had no knowledge of the lymphatics, regarded the veins as the agents of absorption. This opinion was exclusively adopted, until J. Hunter and Cruikshank declared that this function belonged to the lymphatics; and, from that time, they were known under the title of *absorbent vessels*, a name which they retained universally till 1809; at this time Magendie published many experiments to establish, 1st. that a ligature placed round the thoracic duct still allowed an animal to live many days; 2nd. that it neither

accelerates nor retards the effects of poison; 3rd. that poison, applied to a surface which was only connected to the rest of the body by an artery and vein, produced the same fatal effects on the system; 4th. that coloured and perfumed substances are found after a very short time in the venous blood, and not in the lymphatic vessels. Magendie concluded from these facts that the veins absorbed, and that, of the lymphatics, the chyliferous tubes alone exercised this function, and that only with regard to the chyle. This opinion was adopted by the most celebrated German physiologists, who repeated and modified the experiments of Magendie; particularly Ribes, who discovered, by means of injections, the free orifices of venous radicles, and who observed traces of pus and fat in vessels with black blood, while he searched for it in vain in the lymphatics. To complete this series of facts, Séglas submitted poisonous substances to the surface of a portion of intestine, which he had carefully isolated, and whose blood-vessels he had tied, with the exception of an artery and vein, which were both necessary to the vitality of the part. Poisoning did not take place until he had united another vein. All these experiments, and others very similar, affording the same results, gave rise to the opinion, which is adopted at the present day by many physiologists, that *the veins alone absorbed*. On the other hand, Fohmann, a German anatomist, proved, in a work upon the communications between the veins and lymphatics, that the latter were not limited to that small number which had been hitherto allotted them; but that they showed themselves, on the contrary, to be very multiplied, both in the lymphatic glands, and in the substance of organs; and it was thus very easy to explain the results of the fore-

going experiments. The important discovery of Lippi, and the labours of Lauth, jun. have since given a fresh authority to those of Fohmann. Lauth adds, that veins are continuations of arteries; that we cannot include in their systems small vessels with free orifices; and that they are impenetrable through inorganic pores. He hence concludes that the lymphatics absorb, and that nothing has proved that the veins perform this function, since those foreign substances, which have been found in the blood, might have been directly carried there, in order to hasten their expulsion, by the numerous lymphatic branches, which are united to them, in the interior of the lymphatic glands, and in other parts of the economy.

Such is the actual state of the question, which has been agitated for many years with regard to the true agents of absorption. There is no doubt the completely physical power of absorbing belongs to both lymphatics and veins, since every tissue in the body possesses it; but it remains to be determined what substances are introduced into and pass through every part of the vascular centripetal system; this is the most material point to be determined.

## II. LYMPHATIC GANGLIA.

*Definition.*—The name of conglobated glands, or lymphatic ganglia, is given to those small ovoid bodies which are situated exclusively in the course of the vessels just described.

*Form and volume.*—These ganglia are more rounded and globular in proportion to their decrease in size, and flatter and

more elongated as they become larger. They vary in size, from that of a small bean to that of an almond.

*Situation.*—They are more particularly found in the neighbourhood of the great articulations, on their side of flexion; for instance, in the axillæ, groins, &c. They are still more abundant in the thoracic and abdominal cavities, and, generally, in those parts which are nearest to the lymphatic trunks, and to those surfaces through which new substances are introduced into the economy.

*Structure.*—These organs are formed by the interlacing of the *afferent vessels*, of certain blood-vessels which inosculate with the latter, and of nervous filaments. The cells, which have been considered as belonging to them, are merely the result of the filling of the lymphatic vessels. They contain a matter analogous to the lymph, but thicker, and its absence is accompanied by their shrinking. These little bodies are immersed in a cellular tissue, which is sufficiently loose to allow of their being slightly displaced. They receive from it a membranous envelope, which is formed by its condensation over their extent.

*Physical characters.*—Lymphatic ganglia are very consistent. Their colour varies according to the contiguous organs. Thus, round the bronchia and spleen, the blood communicates a brown colour to them; they are yellowish in the neighbourhood of the liver, and white in the mesentery.

*Vital properties.*—These are too obscure to be remarked during health.

*Varieties from age.*—Lymphatic ganglia are larger, softer, more coloured, and more active, during infancy than at any other period of life. In old age they decrease so much,

that some authors affirm that they disappear at that time in certain parts.

*Functions.*—We know but little of the functions of the lymphatic ganglia; we can only suppose that the lymph and chyle undergo a modification in them, and then begin to mingle with the venous blood.

### MORBID ANATOMY OF THE LYMPHATIC SYSTEM.

Congenital anomalies are very common in the lymphatic system. Thus, the thoracic duct is sometimes double, or rather it is given off before it arrives at the subclavian vein; the ganglia also vary much both in number and situation. Lymphatics are not found in newly formed tissues. These vessels are subject to dilatations analogous to varices, which are equally produced by mechanical causes. This affection here takes the name of *cirsus;* it is rarely accompanied by any organic alteration of the membranes. We sometimes see a portion of a lymphatic vessel replaced by a series of small vesicles, which have been thought by some authors to be hydatids, but ought always to be considered as dilatations of these vessels, between the spaces of a pair of valves, together with the obliteration in the parts corresponding to the latter. Inflammation often occurs in the lymphatic system; it generally takes a very slow course, and gives rise to several phenomena, which are attributed to a scrofulous diathesis. Suppuration, effusion of albuminous matter, and obliteration by thickening of the coats of the vessel, may be the consequence. In the lymphatic glands, it more generally terminates in white induration than in any other kind

of organ. They are also very subject to schirrous, carcinomatous, and tubercular degenerations. Ossification, or rather the formation of a calcareous substance, is more rare in the lymphatic vessels than in the ganglia, where they may at times be seen, even in early life.

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# CHAP III.

## THE SEROUS SYSTEM.

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### SECTION I.

#### GENERAL CONSIDERATIONS.

*Definition*—The serous system is composed of an assemblage of a great number of membranous cystiform organs, distinct one from another, presenting a surface which adheres to the surrounding parts, and a free surface contiguous to itself, which is lubricated by a liquid more or less analogous to the serum of the blood; from hence named serous membranes.

*Division.*—The serous system is divided into the *splanchnic*, which includes the serous membranes in the cavities of this name, and also the tunica vaginalis of the testicle; and into the *synovial system*, which, as we shall soon see, presents many subdivisions.

*Conformation.*—As this system does not constitute one uniform whole, it cannot have a general form. The different membranes of which it is composed represent shut sacs; and we can give no better idea of them than by comparing them, with Bichât, "to those double night-caps which fold back on themselves, and in which the head is enclosed."

The peritoneum, however, varies slightly from this cha-

racteristic conformation of the serous membranes. The Fallopian tubes penetrate its cavity, and afford, by this arrangement, the only example of the continuation of serous and mucous membranes with which we are acquainted in the body.

*Surfaces.*—The serous pouches adhere to the contiguous parts by their external surface, in some parts very closely, and in others the reverse. Thus they cannot be separated from the lungs, spleen, testicle, nor from the articulating extremities, unless at the parts where they commence to cover these organs; while the union of serous membranes with the muscles and certain glands is very loose. The former are equally easy of separation from the subjacent parts in the neighbourhood of those points where they pass from one organ to another. The external surface is slightly unequal, wrinkled, and covered with a cellular layer, whose density varies much in different parts of the same membrane. This surface forms, by reflections in some parts on itself, a certain number of folds more or less considerable, of which the omentum and mesentery are remarkable examples.

The internal surface, lying in contact with itself, is smooth, shining, and always moist. With the microscope we can perceive it scattered over with villosities.

*Texture.*—These membranes are formed of a single layer, whose texture is closer the nearer we examine its free surface. Their tissue must be considered as a modification of the cellular. In fact, when a portion of serous membrane is forcibly distended, we perceive a multitude of small laminæ and filaments irregularly interlaced. Besides, organs of this kind do not appear red except in an inflamed state, a character which belongs equally to the laminated tissue.

This is, as well as the former, the seat of a serous exhalation, whose products are nearly the same. The serous accidental membranes (cysts) are also formed in the cellular tissue by simple condensation: both tissues putrefy with the same slowness, and their maceration is equally long. Most authors regard the serous membranes as being well supplied with white but deprived of red vessels*. Rudolphi and Ribes go further, and, from the results of very minute dissections, deny them any species of vascularity.

*Physical and chemical characters and properties.*—Serous membranes are white and transparent, and possess an elasticity which is particularly remarkable from the facility with which we see them resume their first dimensions, after they have been submitted to considerable distention. Though very elastic, they are not, however, so much so as we should be led to think from the remarkable extension they present in certain dropsies. In fact, we must not forget, 1st. that these membranes, in their natural state, present many folds, which are effaced during disease: 2nd. that they may be very considerably displaced, when the cause of distention acts only on a part of their extent. Maceration renders them opaque, and desiccation increases their transparency. When submitted to long boiling, they furnish gelatine and albumen.

*Vital properties.*—Serous membranes possess no sensibility, at least in their healthy state; it is probable that

* The transparence of serous membranes allows us to see vascular nets, which are situated, not in their substance, as we should be induced to believe, but in the sub-serous cellular layer.

a kind observed in inflammation arises from the subjacent tissues. Their nutrition would lead us to believe in their vitality, which is not otherwise remarkable.

*Varieties from age.*—The serous system presents an extreme tenuity in the fœtus. The arachnoid and epiploon, which are the most attenuated parts of it during the whole of life, in the fœtus, have scarcely the thickness of the parietes of a bubble of soap. The density of these membranes increases with age: it is very remarkable in old age; and they then lose a great portion of their suppleness. At this period, adhesions of these organs to the contiguous parts become firmer and more resisting; while, in infancy, they are loose and weak. It is probable that serous membranes, or at least the splanchnic portion, do not form shut sacs from the beginning. They afterwards undergo every necessary change of form, and accommodate themselves to the parts which they surround or line.

*Functions.*—These membranes separate the organs which they envelope, and between which their cavity is interposed. This separation is rendered more complete by the presence of serosity, which lubricates their free surface: without this, the contiguous parts would form adhesions with them, and, by its assistance, the above organs glide more easily over each other. With regard to the secretion of this fluid, Ruysch has shown that it was not effected by the glands, as was supposed before him. It is now considered the effect of a perspiratory secretion, an organic action of the serous tissue, or of the vessels alone, which enter into its texture. Many very distinguished physiologists think that its texture only assists in the exhalation as an hygrometrical sub-

stance*. The product of this perspiration varies according to the species of serous membranes. It enters into the circulating passages in proportion as it is exhaled; and, during this double movement, it probably undergoes a modification which renders it more fitted for nutrition. Bichât, in showing that the extent of the serous surfaces, without including the synovial, possess more of this secretion than the integumentary membranes, has noticed the importance of the exhalation and of the absorption, of which the former are the seat.

### MORBID ANATOMY.

Serous membranes are sometimes thickened at the same time that their extent is increased. This phenomenon, which is remarkable in herniæ and dropsies, results from an increase of nutrition. Solutions of continuity of these organs are followed by a linear cicatrix, which is almost imperceptible when the union is immediate; and by the formation of a new portion of serous membrane when we have not succeeded in uniting the lips of the wound by the first intention. This portion always remains thin, and more extensible than the remainder of the membrane. The first effect of inflammation is to suspend the exhalation of the serosity; it then increases it without altering its nature, and finally changes,

* Rudolphi, who denies every species of vessels in this system, thinks that the exhalation of the serosity is effected by the vessels beneath the serous membranes, and that this fluid passes through them to arrive at their free surface, in the same manner as the product of the cutaneous perspiration traverses the epidermis.

which takes place in various ways. Sometimes, therefore, the product of the serous exhalation is a lactescent liquid, holding some albuminous flocculi in suspension; sometimes it is a more consistent substance, of a gelatinous appearance, which is deposed upon the free surface of the membrane in small particles, which become united and form layers of variable extent. These latter are often agglutinated with those which are found on the part contiguous to the free surface. These pseudo-membranous productions frequently become organized and establish permanent adhesions between different portions of these organs. In this case, they assume the consistence of cellular tissue, and afterwards that of serous tissue. Vessels are observed to be formed in their centre, which extend on every side and terminate by their ramifications with the vessels of the parent membrane. They adhere to the latter, sometimes by one point and often by their whole extent. Their disposition, form, and thickness vary much. These productions are found under the form of bridles, filaments, fringes, membranes, &c. They are most frequent in the pleura, and then in the peritoneum: the synovial membranes present some after rheumatism. They are subject to cartilaginous and osseous transformations. Inflammation of serous membranes gives origin to a secretion of purulent matter, which, according to its thickness and abundance, remains spread over the free surface, or is collected into the most dependent part of the cavity. Chronic inflammation in some parts may transform the serous into fibrous, cartilaginous, or osseous tissues, which are usually observed under the form of plates, either on the adhering surface, or in the thickness of the membrane. The cardiac surface of the pericardium often presents examples

of this kind. Concretions of the same nature, either pediculated, or free (but which do not become so until after their formation), are sometimes found in the serous cavities, and particularly in the synovial. Tubercles are also found in this tissue.

It is to a subacute inflammation, or at least to a continued irritation of the cellular tissue, that we must attribute the formation of accidental serous membranes, known under the name of *cysts*—a denomination which indicates their vesicular form, but which is equally given to certain sacs whose tissue approaches more to those of the integuments than to that of true serous membranes. The serous cysts, the analogy of which with the serous system Bichât has clearly shown, result generally from a condensation of cellular tissue, round a sanguineous effusion of a purulent or serous collection of foreign bodies, and of certain tumours, &c. Others are owing to the developement of a pre-existing sac; as in those which result from an enlargement of the ovarian vesicles; those of the spermatic cord, produced by a partial distention of the tunica vaginalis, &c. We shall not include under the same head the atheromata, steatomata, and meliceria, as their tissue is not that of serous membranes, but of the integumentary organs, as we shall see hereafter. Cysts may present all the degrees of the organization of serous membranes with similar alterations. They exhale and absorb the same fluid. *Hydatids* are a species of cyst, which are distinguished from the others, inasmuch as they do not adhere to the surrounding parts. They are met with in a greater or less number in certain organs, as in the brain, liver, uterus, &c. In serous membranes and in true cysts they are filled and surrounded by serosity, and appear to be

produced by the organization of this fluid. Their parietes seem soft, like concreted albumen. These productions have been enumerated among the entozoa by Laënnec, who has described them under the name of *Acephalocysts.* Cuvier, Rudolphi, and Meckel refuse them a place in the zoological tribe.

The accumulation of serosity in the cavity of the serous membranes is a kind of affection which constitutes dropsies, and arises from a defect in the equilibrium between the exhalation and absorption of this fluid. When the former exceeds its usual quantity, which circumstance frequently depends on inflammation, either acute or chronic, but always slight, it is called *active* dropsy; and *passive,* when the exhalation remains natural and the absorption is languid. This frequently arises from a derangement of the circulation, and an engorgement of the venous system, which is the frequent consequence of some deep-seated alteration in the splanchnic organs.

We shall show, in the following sections, the small number of malformations which occur in the serous membranes.

## SECTION II.

### THE SPLANCHNIC SEROUS MEMBRANES.

Syn. Simple villous, diaphanous, membranes, &c.

*Definition.*—The splanchnic serous membranes line the cavities of this name, and cover more or less completely the organs which are contained in them.

*Division.*—Some are simple, others are in pairs. The arachnoid in the cranium, the pericardium in the thorax, and the peritoneum in the abdomen, compose the first series. The second comprehends the two pleuræ, which occupy individually a lateral half of the chest, and the two tunicæ vaginalis, each attached to a testicle.

*General conformation and disposition.*—Their form is similar to that of the other serous membranes, which is that of shut sacs*. We shall recall, as respects their general disposition, the comparison which Bichât made between these membranes and a cap folded back on itself, so as to form an external and an internal sac, continued to the part where they are reflected one over the other, and contiguous by one of their surfaces. The external sac (the parietal coat or

* We must not forget that the peritoneum alone does not partake of this general character of serous membranes, since the Fallopian tubes penetrate its cavity.

sac) adheres to the parietes of the splanchnic cavity; the internal (the visceral sac or coat) is spread over the organs contained in this cavity, and envelopes them more or less completely. In this sense, the pleura costalis is distinguished from the pleura pulmonalis, although both actually form but one serous membrane in each lateral division of the chest. The disposition of the parietal sac presents nothing very remarkable; but that of the visceral sac is very complicated in the arachnoid and peritoneum. The former furnishes sheaths of various length to the cephalic vessels and nerves; and the latter is found in relation, variously combined, with different organs. Sometimes the parietal sac is suddenly reflected, to line the visceral parts and to cover organs which it does not ordinarily completely invest; for example, the ascending and descending portions of the colon. At other times, the membrane quits the parietes of these cavities, and passes through a short course before it covers the organ to which it is going, and then envelopes it entirely, except where it receives vessels and nerves, and afterwards becomes reunited to itself; as we see in the mesentery. The visceral sac presents another kind of fold, when, after having covered a part only of an organ, it is more or less separated from the latter, but is afterwards reflected on itself, to cover the other portion. The folds of this latter species of duplicature may be floating, as the epiploon; or kept fixed by the continuation of the lateral portions with the parietal sac; as, for example, the broad ligament of the uterus. In general, the sacs of the duplicatures we have just described are united by a sufficiently loose cellular tissue to allow of their separation, when the organ to which it corresponds is increased in volume.

*Surfaces.*—The external surface is every where adherent, whether it be to the parietes of the splanchnic cavities, or to the viscera and a certain number of vessels and nerves, or, lastly, to itself by the folds just mentioned. The arachnoid alone, and that only at one point of its extent, presents an example of the non-adhering surfaces of a serous membrane. We have already shown the varieties presented by the union of serous membranes with the parts which they cover: it is in those parts where the parietal sac is reflected over the organs that this union is least intimate.

*Texture.*—The splanchnic serous membranes resemble, in point of fact, large webs of cellular tissue, but modified in their density. Their fibrillous appearance is not so distinct in them as in the synovial membranes. They are considered to be more furnished with white vessels than the latter*. With regard to the red vessels, which seem to penetrate them, they are merely subjacent, and abound especially between the layers of the folds, where also is found some adipose tissue. We have already seen that we cannot trace nerves in the serous membranes.

*Physical and vital properties.*—The extensibility of the splanchnic serous membranes exceeds that of the synovial. Their other physical and vital properties present nothing of importance.

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* The arachnoid is an exception to this rule, and is considered as completely devoid of vessels; at least none have been discovered by injection. On this account, and from its extreme tenuity, this membrane, which presents, in other respects, the general conformation of serous sacs, has been regarded by many anatomists as forming a separate genus. But if it be true, as Rudolphi supposes, that the whole class of these membranes are deprived of vessels, this distinction is without foundation.

*Functions.*—The fluid which is exhaled from the free surface of serous membranes is so very small in quantity in health, that it merely moistens them. It coagulates very readily by being exposed to the air: this is owing to the albumen which enters into its composition and is found in it, but in less quantity than in the serum of the blood. The incoagulable portion of this serosity is, according to the researches of Béclard, a gelatinous mucus. These membranes separate the viscera and parietes of the splanchnic cavities, at the same time that they facilitate their reciprocal movements by the polish of their free surface. They also strengthen the parietes of a great number of vessels, to which they furnish sheaths during a small portion of their extent, and support also those of certain membraniform organs, as the stomach and intestines.

### MORBID ANATOMY.

The form of these membranes, as well as their relations with the surrounding organs, are frequently changed by an accumulation of this serum. At other times, these changes are caused by displacements of the viscera, and particularly by those called *hernia*—a sort of affection presented especially by the organs of the abdomen, and particularly by the intestinal canal. An organ, issuing from the splanchnic cavity, which is itself invested with a serous membrane, pushes before it a portion of the parietal sac, which is placed before the orifice through which the organ issues. This portion thus furnishes a second envelope contiguous to the first, and constitutes what is called a *hernial sac.* This

is owing at times, not to a displacement, but to a distention, of the parietal sac; and is what takes place in umbilical herniæ. Alterations of texture in the splanchnic serous membranes are the same as those of which we have spoken in the preceding section; and we shall only add, that they are more frequent in this than in the following kind. Among the small number of the malformations of these membranes we find: the absence of one of their portions, particularly the anterior, the permanence of the continuation of the cavities of the peritoneum and tunica vaginalis, &c. There has also been remarked a serous sac, placed in the interior of the peritoneal sac, and communicating with it by a small orifice.

## SECTION III.

### THE SYNOVIAL MEMBRANES.

*Definition.*—The synovial membranes are serous organs, spread in great variety over the apparatus of locomotion, and placed between those surfaces which move over each other.

*Division.*—They are divided into subcutaneous synovial bursæ, into synovial membranes of the tendons, and into those of the articulations.

*Form and disposition.*—Each of these differ in many respects in the three species of synovial capsules. Thus:

1st. The *subcutaneous bursæ* are simply small, rounded vesicles, easily seen by inflation, and situated between the skin and certain osseous or cartilaginous parts, jutting out from below it; they are found between it and the trochanters, patella, olecranon, &c. They adhere by their external surface to the surrounding tissues, and are sometimes connected with the neighbouring tendinous capsules, and are thus contiguous to themselves by their internal and free surface. The cavity of some of these vesicles is divided into many cells by partitions which are more or less complete*.

2nd. *The synovial membranes of tendons* present two very distinct forms. One of these is *vesicular*, and is found interposed between tendinous parts, and bones or cartilages, or between tendons only; they embrace these different

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* We owe the first good description of these organs to Béclard.

organs, and adhere pretty intimately to them by their external surface, which is united in some parts to the subcutaneous bursæ, or to the synovial membranes of the neighbouring articulations. Many of them have folds, which are seen in their cavity under the form of *fringed prolongations;* and to these we shall recur when we speak of the articulating capsules. The synovial tendinous membranes of the second species are the *vaginal;* and they are thus called from their forming complete sheaths round the tendons. These sheaths are composed of two cylindrical superlatent layers, connected by their two extremities, contiguous by one of their surfaces which is free, and adherent by the other. The external coat invests the parietes with a fibrous canal, which is traversed by one or more tendons; the internal coat surrounds them. In some parts, one of the extremities of these tendinous sheaths is divided into many tongue-like processes which are placed over as many tendons.

3rd. The *synovial membranes of the articulations* are all vesicular. It is only in appearance that they lose this form in certain joints. They can always be made to resume it by separating them from the surrounding parts. These organs line the surfaces of the diarthrodial articulations, their ligaments, and every part which immediately surrounds them. The number, form, and disposition of these latter vary much, and proportionably modify the apparent configuration of the membranes to which they adhere. Thus, in some articulations, as in the coxo-femoral, where there is an inter-articular ligament, the synovial capsule is reflected over the latter, which provides it with a sheath, and gives to this membrane the complete appearance of a vaginal conformation. The

disposition of the synovial membrane of the knee is still more complicated, from the great number of ligaments and tendons to which it furnishes sheaths more or less complete. These membranes adhere so intimately to the cartilages, that they cannot be separated from them at the centre. Many anatomists, and among others Magendie, say that they do not extend beyond the circumference, but merely surround them; but an attentive examination shows the contrary; and certain pathological facts, particularly the presence of pseudo-membranous adhesions on the centre of articulating surfaces, prove the existence of synovial membranes at these parts. They present folds analogous to those formed by the splanchnic serous membranes; namely, folds floating in their cavity, fringed at their free edge, and on this account termed *fringed prolongations.* These duplicatures, which we have already found in the vesicular capsules of tendons, contain cellular tissue and many vessels between their coats. There are also seen, both within and without these coats, some fatty bodies which Havers mistook for glandular masses, and which his successors, by adopting his opinion, have called the *glands of Havers.*

*Texture.*—The tissue of the synovial membranes, and particularly of the two first species, is only distinguished from the cellular by their greater density. They have, it is said, white vessels, which are rendered visible by inflammation. Some of the articular membranes appear to have lymphatic vessels. Their nerves, if they possess any, are as little known as those belonging to the other serous membranes.

*Physical characters and properties.*—All the synovial membranes are whitish, semi-transparent, thin, and soft.

Their extensibility appears less than in the splanchnic serous membranes.

*Vital properties.*—The extent of vitality in these organs is not cognizable, like other serous membranes, but by the possibility of their inflammation*.

*Varieties from age.*—The subcutaneous bursæ are easily seen from birth, when their synovia is more copious than at any other period of life. Their extent and density increase in proportion as the parts in which they are situated are exercised. Béclard, Bogros, Breschet, and Willermé, supposed that the tendinous synovial membranes were developed consecutively to the friction of the tendons over the contiguous parts. They are formed, in fact, in every part where the skin becomes the seat of constant pressure. (Example, in the stumps of amputated limbs.) Soemmering observes, that their number diminishes with age by the union of those which touch each other. In fact, the synovial membranes are very thin in the fœtus and infant; become more and more dense; and put on a certain rigidity in old age. The synovia is not so consistent in children; it is less abundant in old persons, and before birth than in the intermediate ages.

*Functions.*—Synovial membranes facilitate the reciprocal movements of the parts between which they are situated; and this arises from the polish of their surfaces, which is owing to the presence of a fluid called synovia, and which is there constantly exhaled and absorbed. This fluid is most

* That is, if this morbid condition has not its seat, as Rudolphi supposes, in the subjacent tissues, and not in the serous membranes themselves.

abundant over the fringed prolongations, in consequence of the great number of vessels which are placed between the layers of these duplicatures; and not, as stated by Havers, from the presence of a glandular apparatus, the fringes of which were the excretory ducts. The synovia exudes at every point of the free surface of those which have no fringes, as well as in others; and this alone would overturn the hypothesis of Havers. This fluid varies a little in the three kinds of synovial membranes. In the mucous bursæ it merely moistens the membrane and renders its touch unctuous. In the tendinous pouches it is more abundant, thick, viscous, yellow, verging sometimes towards yellow, and composed of albumen and mucus. In the articular membranes it is equally viscous, ropy, of a saltish flavour, and composed of water, albumen, fibrine, and mucus, of certain salts of soda and lime, and also, according to Fourcroy, of a matter which appears to be uric acid*.

### MORBID ANATOMY.

Dropsies of the subcutaneous bursæ (*hygroma*) and of the tendinous bursæ (*ganglion*) are not rare; but dropsy of the articulating capsules is extremely so (*hydrarthrosis*). At times the accumulated synovia preserves its natural character; at other times it is changed in various ways. In the two first species this fluid often resembles currant jelly. Collections of puriform or purulent matter may follow inflammation of

* This will explain the formation of the concretions of urate of soda in the joints.

the synovial membranes; this morbid condition is not so frequent in these as in the splanchnic serous system. It is sometimes followed by ulceration, or the production of fungous granulations, and the conversion of the articular capsules into a pultaceous substance, of a clear brown colour, intermixed with white streaks, sometimes of half an inch in thickness, and which gradually extends over the whole joint. Inflammation of these membranes sometimes also terminates in their becoming thickened, and by the formation of pseudo-membranous adhesions, which vary in form as much as in the other serous membranes. Sometimes they are bands, which, by their number and direction, represent a kind of cellosity; at other times, they are membraniform layers, uniting surfaces which before were free and contiguous. All these productions impede more or less the motions of those parts between which the membrane is placed: they constitute a variety of *false anchyloses;* which disease frequently results also from a thickening with induration of the articular synovial membrane and of the adjacent tissues. The adhesion of two contiguous parts of the articular capsule is often followed by their disappearance; then by that of the cartilages; and lastly by the union of the osseous extremities, or *true anchylosis.* Certain foreign bodies are found in the synovial membranes. Those of the tendons sometimes contain cartilaginous productions; and, at other times, small bodies of the size and shape of the pips of pears, and which some have supposed, but falsely, to be endowed with a peculiar vitality. There are also found, in the articular capsules, certain fibrous, cartilaginous, or bony productions, both free and pediculated, or lodged in the thickness of the cartilage. Saline concretions also,

composed of the urate of soda have been met with in them. In some instances, new synovial membranes are formed; as is seen between the two fragments of a non-united fractured bone. Congenital malformations of these organs are as yet but little known.

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# CHAP. IV.

# THE FIBROUS SYSTEM.

## FIRST DIVISION.

## FIBROUS (PROPERLY SO CALLED) OR INELASTIC SYSTEM.

### SECTION I.

### GENERAL CONSIDERATIONS.

SYN. Albugineous, tendinous, aponeurotic, ligamentous, tissue*.

*Definition.*—The fibrous system comprehends a great number of organs of various forms; it serves different uses, but possesses for its common character a white, shining, very resisting tissue, and presents fibres which are more or less distinct.

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* Neither of these denominations is exactly applicable to this system; for they all express, either a character which it possesses in common with others, or one form only which it puts on. The first objection is applicable to the name *fibrous*, but which we shall nevertheless preserve in this system, as the one most generally adopted.

*Division.*—This system is composed of various kinds of organs. 1st. the *fibrous ligamentous organs*, which include the tendons and ligaments; 2nd. the *fibrous enveloping organs*, among which we find those of the muscles (aponeuroses), those of the bones and cartilages (the periosteum and perichondrium), those of certain nervous, glandular, organs, &c. (the dura mater on the brain, the sclerotica on the eye, the albuginea on the testicle, &c.); each of which we shall investigate separately.

*General conformation.*—We find two principal forms in the system of fibrous organs; the funicular or fascicular, and the membranous. The former belongs exclusively to the tendons and ligaments; the latter to that of the envelopes, and is also found in the two preceding kinds. Bichât has represented the periosteum as the centre of the fibrous organs, supposing that the tendons, ligaments, and aponeuroses, as well as the fibrous envelope of the corpora cavernosa and dura mater, are all connected with this membrane, to every part of which they are also united: but this observation cannot possibly authorize the admission of a centre of the fibrous system, since certain envelopes of glandular organs which belong, as well as the above-mentioned organs, to this system, have no communication whatever with them.

*Texture.*—All fibrous organs are composed of an assemblage of fibres, which are very distinct in most of them, but almost imperceptible in others. At times they are disposed in bundles, almost parallel to each other, sometimes interlaced in various ways; and, at other times, they form several thin and crossed layers, as we see in the aponeuroses. These fibres are white filaments, finer than hairs, and possess all the physical characters which we shall presently recognize in the

tissue to which they belong. Chaussier ranks this species of fibres under the name of *albugineous*, among the four which he admits as *elementary* in our organization; but they are now generally regarded as the result of condensed cellular tissue. This latter surrounds and unites the fibres and the bundles which they form, and furnishes envelopes to the organs they compose. These organs contain a small quantity of adipous tissue. They present remarkable varieties in their vascularity. Thus, certain large tendons appear to have no blood-vessels, while the periosteum and dura mater possess many. Some receive lymphatics. Nerves have not been traced in them.

*Physical and chemical characters and properties.*—The fibrous tissue is white; it generally presents a brilliant silvery appearance; it is hard and resisting; distention cannot be produced but very slowly. When some powerful cause is applied, the fibrous organ itself is ruptured, or, should it resist, the bones, &c. to which it is attached are fractured. From this want of extensibility depend those accidents known by the name of *strangulations*, which arise from the insuperable obstacle opposed by the fibrous organs to the developement of parts usually surrounded by them, from their volume being suddenly increased by inflammation or other causes. The fibrous tissue retracts slowly proportionate to that of its extension; that is, it has but little elasticity, at least in its recent state. Desiccation gives it this property, and renders it transparent, of a reddish yellow colour, and almost homogeneous. But it requires to be macerated in water for some days to restore its original characters. Long maceration first separates its fibres, then softens and changes them into a whitish pulp. This tissue is finally

reduced to gelatine by boiling; it is digested with great difficulty, and is decomposed very slowly.

*Vital properties.*—The sensibility of the fibrous system is, it is said, excited in health by violent extension, as in sprains: this extension produces excessive pain, and may give rise to very intense inflammatory injuries*. A fibrous organ may be pricked, cut, and submitted to the action of chemical irritants, without occasioning any pain. Every irritating cause may also act on this tissue, and produce inflammation. It never presents contractions: reparation is very active.

*Mode of developement and varieties from age.*—The fibrous texture is not visible in the fœtus until the third month. This tissue is of a pearly white colour in the infant; it then yields easily to free motion, and, being more extensible, is less easily ruptured. At this age, the periosteum, dura mater, and sclerotica are more developed than in after life. In old age this tissue is dense, stiff, more yellow, and less smooth, than in the adult. Notwithstanding its hardness, it is not liable to senile ossification, unless it be in those parts which are exposed to the friction of the bones, and in certain parts where they resemble cartilages.

*Functions.*—These vary, as we shall see, according to the kind of fibrous organs, and are all purely mechanical.

## MORBID ANATOMY.

When fibrous organs are submitted to long extension,

* Many persons, and we among the number, suppose, against the general opinion, that it is at least doubtful whether this pain ought to be referred to the ligaments rather than to the nerves of the injured part.

which cannot take place without their emaciation, they become thicker in consequence of the increase of nutrition. Their wounds heal by the interposition between their lips of an organizable matter, which finally acquires the density of fibrous tissue. Inflammation of this tissue rarely terminates in gangrene or suppuration, but more generally in resolution, or by a thickening of the organ. Chronic inflammation of fibrous organs produces cartilaginous and bony transformations, softening, growth of fungus, polypi, and carcinomatous tumours. The fibrous tissue is developed accidentally round certain cysts and tumours, round false articulations, and in some adhesions of serous membranes. Cicatrices of the liver and skin are formed of a tissue resembling it. We may also consider as similar certain polypi and subcutaneous tumours, which we find especially between the rectum and vagina, and between the latter and the bladder. Those fibrous bodies found in certain parts, as in the womb and ovaries, and which have been confounded with scirrhus, though without any resemblance to it, are productions of various kinds, round, lobulated, at first very small, soft, and increasing gradually in volume as they acquire solidity, lodged sometimes in the substance, sometimes on the surface of the parietes of the uterus, and very slightly adhering to them in the latter case. These bodies are composed of two substances, disposed in layers, one of which is fibrous, and the other of a homogeneous texture. The latter is regarded as cartilaginous by J. F. Meckel, who considers these bodies to be fibro-cartilaginous. Cellular tissue and blood-vessels enter also into their texture. They are not unfrequently converted into cartilages and become ossified. Calculi, said to have been found in the uterus, are frequently only lobes of these bodies.

## SECTION II.

## ORGANS WHICH COMPOSE THE FIBROUS SYSTEM (PROPERLY SO CALLED).

### FIRST ARTICLE.

### FIBRO-LIGAMENTOUS ORGANS.

This kind comprehends the *Ligaments* of bones and cartilages, and the *Tendons* which unite the muscles with the hard parts.

### § I.—THE LIGAMENTS.

*Definition.*—Ligaments are fibrous organs of various forms, adhering, at least by their extremities, to the bones, or cartilages.

*Division.*—They are divided according to their situation: 1st. Into *articulating,* which unite different bones by being attached to each of them; 2nd. into *non-articulating,* those which are connected by one part to another of the same bone, either to form fissures into foramina (as in the acromio-coracoid ligament), or to obliterate an osseous cavity (as in the posterior pubic ligament), and thereby enlarge the surface for the insertion of muscles; 3rd. into *mixed,* where they especially answer the latter purpose by filling up the spaces between different bones; as in

the peroneo-tibial, the radio-cubital, and the sacro-ischiatic interosseous ligaments.

*Form and kind.*—Every species of ligament presents the two general forms of fibrous organs, the fascicular and membranous. Fascicular ligaments are generally more broad than thick; and their particular form is commonly that of an oblong square; they are seldom triangular. Those of the articulations are either external or internal, as respects them. The external are placed so as to limit or prevent motion in certain parts; the greatest number of them are lateral. They adhere internally to the synovial capsule, and externally to the tendons, &c. which surround the articulation. The internal are fibrous cords, which we meet with in the centre of the coxo-femoral articulation and in that of the knee, cords bound by their extremities to the centre of the articulating surface, and adhering in the remainder of their extent to the synovial capsule, which provides them with a sheath in being reflected over them. Membranous ligaments have a varied form which corresponds in the non-articulating to that of the spaces which they supply.

Those of the articulations (they are only found perfect round the scapulo-humeral and the coxo-femoral) are named *capsular ligaments:* they appear like large fibrous sheaths which embrace the joint, and are attached by each of their extremities to the centre of one of the bony parts which form this latter. These capsules or fibrous sheaths intimately unite, by their internal surface, to the external synovial membrane, and by the other surface to the tissues surrounding the articulation. They allow of motion in every direction. The union of the ligaments with the bones or cartilages is very intimate in the adult, and in old age, but less so in infancy;

at this latter period, these organs are almost exclusively attached to the periosteum.

*Texture.*—The tissue of the ligaments is very compact; its fibres are not equally distinct in all. They have some blood-vessels and a little fat.

*Functions.*—These organs, both pliant and resisting, are opposed to certain motions which might affect their extension, and allow of others which are dependant on their flexibility. The non-articulating serve especially for the insertion of muscles.

*Alterations.*—Ligaments, particularly the capsular, are torn in luxations. Their inflammation is frequently seen, especially in white swellings.

Inflammation may also give rise to their ossification, softening, gradual wasting, &c.

## § II.—OF THE TENDONS.

*Definition.*—Tendons are termed ligamentous organs, which unite muscles to bones or cartilages, or even two portions of the same muscle.

*Division.*—They are divided, according to their form, into *funicular tendons;* and into *aponeurotic tendons* or *aponeurotic insertions.*

*Situation and relation.*—Tendons are most frequently situated at the extremities of the muscles, and are then inserted by one of their portions into them, and by the other into the hard parts or aponeurotic coverings. At other times they interrupt the course of the fleshy fibres, and give to the muscles the

digastric, trigastric, &c. forms, when that separation is complete.

The funicular and aponeurotic tendons are sometimes met with on the same muscle; and then the former kind is attached to the most moveable bone, and the latter, or membranous, to the point of insertion. The union of the tendons with the fleshy fibres is throughout very intimate. This takes place sometimes obliquely, in crossing each other, over a part of their extent, and often affords an analogous form to the beard of a pen folding on its stem; at other times, the tendinous fibres follow the course of the muscular, of which they appear to be a continuation. In many places, the synovial bags surround more or less completely the tendons; they sometimes pass in fibrous sheaths, which we shall presently describe; at other times they are connected with a loose cellular tissue.

*Conformations.*—*Funicular tendons* are cords more or less elongated, round or flat, sometimes uniform in their whole extent, at other times divided at one of their extremities into several distinct parts. The *aponeurotic tendons* are equally simple or divided; many of them form arches whose two extremities become inserted into the hard parts, the concavity of which gives passage to vessels. Some tendons are partly funicular and partly membranous; lastly, there are muscles which terminate in very short fibrous fasciculi, separated from each other, and which cannot be classed under either of the two species of tendons just described.

*Texture.*—The tissue of tendons is very compact: their fibres, more or less distinct, are united by rather a small quantity of cellular tissue. It is without any kind of foundation that some have wished to regard their organization as

similar to that of the muscles, which have only in common with them the cellular tissue which passes from one to the other. Tendons have very few vessels. Those which suffer much friction from the bones ultimately become fibro-cartilaginous, and even osseous.

*Physical and vital characters and properties.*—Tendons are of a pearly white appearance, shining, dry, and inelastic; their vitality (particularly that of the funicular) appears to be inferior to that of other fibrous organs.

*Functions.*—The tendons unite the muscles to the hard parts, afford an extended surface of insertion to their fibres, by which they are rendered more numerous than if they were immediately united to those same parts, and, lastly, they assist the action of these latter by concentrating it upon a space more limited than that which they occupy.

*Alterations.*—Inflammation of the tendons is little known; their puncture produces an indolent swelling, which is very slowly resolved. They partake of the softening of the ligaments in white swellings. When exposed to the atmosphere, and deprived of their cellular tissue, they easily mortify and exfoliate.

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## SECOND ARTICLE.

### OF THE COVERING OF FIBROUS ORGANS.

This kind comprises: 1st. the fibrous envelopes of the muscles or aponeuroses; 2nd. the sheaths of tendons;

3rd. the covering of bones, or the periosteum; 4th. that of cartilages, or the perichondrium; 5th. that of the nervous system, or dura mater; and 6th. some others belonging to different organs, which we shall presently describe.

## § I.—APONEUROTIC COVERINGS.

*Definition.*—The aponeuroses are fibrous membranes, which cover more or less completely one or more muscles.

*Division.*—They are divided into general and partial; the former belong to the extremities, the latter to the body.

*Conformation and disposition.*—The *general envelopes* resemble the form of the limbs the muscles of which they surround. They are connected with these latter by their internal surface, and send between them membranous prolongations, which, in separating them one from the other, furnish points of insertion to the fibres of many of these organs, and go to be attached to certain lineary projections in the bones.

The external surface is united by a loose cellular tissue to the integuments, to the adipous tissue, and to the subcutaneous vessels. These aponeuroses unite at their extremities with the periosteum, or with the cellular tissue, and form fibrous rings for the passage of tendons.

The *partial aponeuroses* have a varied form, aud cover or surround imperfectly certain muscles on the sides of the splanchnic cavities. There are some which cover only a single muscle (as the temporal); others which belong to several of these organs.

Some correspond, by their internal surface, to the muscles, and by the external to the subcutaneous cellular tissue.

Others are connected by both surfaces to the muscles, and are sometimes composed of many layers which receive these latter between their spaces, similar to species of folds; an example of which may be observed in the recti muscles of the abdomen.

The aponeuroses have *tensor muscles*, which are sometimes proper to them (the fascia-lata with the aponeurosis of this name), and at other times destined for other functions, and only fulfil, in an accessory manner, the office of *tensors*, by means of the insertion of their tendon into the aponeurotic membrane; as in the biceps brachialis, which is united in part by its inferior extremity to the anti-brachial aponeurosis. These muscles modify the degree of tension of these envelopes, which is dependent on the contracted or relaxed state of the subjacent muscles.

*Texture.*—The tissue of aponeurotic envelopes is composed of one or more sets of fibres, arranged in different orders.

*Physical characters.*—These membranes appear of a pearly white colour; their thickness is in direct relation to the number, to the strength, and activity of the muscles which they cover. Their fibres are more rigid and more resisting than those of the tendons; they also resist for a longer period maceration and boiling.

*Functions.*—The aponeuroses maintain the subjacent parts in their position, from the motions which might otherwise change it. They assist the progress of the venous and lymphatic fluids, and prevent, by their inelasticity, the accumulation of these latter beneath them.

## § II.—SHEATHS OF TENDONS.

*Definition.*—Those expansions of the fibrous tissue are thus called which form alone, or with the assistance of the neighbouring bones, species of canals through which pass one or more tendons.

*Division.*—Tendinous sheaths are general or partial, according as they receive several or only one tendon.

*Situation.*—They are found principally at the free extremity of the limbs, and chiefly in the situation of the joints; an arrangement required on account of the greater number of the flexor muscles compared with the extensors. Thus, besides the strong sheath which all the flexors of the fingers receive, each has its proper one;* whilst the extensors are bound down solely by the tendinous fibres arising from the interosseous muscles.

*Form and character.*—The sheaths of tendons are either complete or incomplete; that is, some form the entire canal which gives passage to the tendons, whilst others form only a certain portion, the remainder being furnished by the bones to which are attached the extremities of the fibrous portions now referred to.

Some form true canals; others merely fibrous rings, and

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* Besides the reason already given, there is another which we shall notice here: it is, when the hand is bent, the very long and slender tendons of the anterior muscles of the fore-arm, if they were not confined to the phalanges by sheaths which do not allow of their longitudinal motions, would be displaced and give to the palmar surface of the organ of touch a form which would impede its functions.

are then termed *annular ligaments.* Those sheaths which receive several tendons are either simple, or compound; that is, divided by fibrous prolongations into as many grooves as they receive tendons. These organs are continuous with the aponeuroses of the extremities where they exist. Their tendinous surface is lined by a synovial pouch of a vaginal form, which, in the compound, sends between the tendons slips which form so many partitions more or less complete.

*Texture.*—They are composed of transverse or oblique fibres, sometimes very apparent, and at other times very indistinct; their tissue is compact and thick, but sometimes thin.

*Functions.*—These organs keep the tendons in their proper situation, and, in some places, serve them at the same time as levers to act upon.

### § III.—OF THE PERIOSTEUM.

*Definition.*—This name is given to the fibrous envelope of the bones.

*Form and character.*—The periosteum has the form of the bone which it covers. Its continuity is only interfered with by the moveable articulations; in the immoveable, it passes without interruption from one bone to the other; it does not, in either kind, cover their articulating surfaces. The attachment of this membrane with the bones is weak in infancy, strong enough in the adult, especially at the extremities of the long and short bones; in fact, wherever the texture

of these organs is spongy. Numerous prolongations of the periosteum accompany the vessels which, in this case, penetrate the osseous tissue.

*Texture.*—The fibres of the periosteum, both of the long and short bones, have the same directions, though they differ from the fibrous envelope of the flat bones. The texture becomes fibro cartilaginous in those parts subject to constant friction. The periosteal tissue receives many blood-vessels and some lymphatics.

*Varieties according to age.*—In the fœtus, the periosteum is soft and spongy, abounding in gelatinous fluids, and slightly vascular; the fibres afterwards gradually appear; its consistence increases, its net-work is developed;—in old age it becomes firm, hard, and even ossifies on its internal surface.

*Functions.*—The periosteum protects the bones from the action of organs which pass over its surface; it strengthens the parietes of their vessels; in infancy it unites the epiphyses to the body of the bone, and receives the insertion of the ligaments and tendons, which, at a later period, and in consequence of the ossification of this membrane at their points of attachment, adhere to the bone itself.

MORBID ANATOMY.

The periosteum, removed to a small extent, may be regenerated*. Its solutions of continuity are followed by cica-

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* Its abrasion gives rise to a superficial necrosis.

trices which resemble it. Its inflammation rarely terminates in gangrene; sometimes in suppuration (and in this case it detaches itself from the bone); at other times, that morbid condition gives rise to induration with an increased thickness (periostosis), ossification, and, lastly, encephaloid carcinomatous wasting, and the developement of fungous productions.

### § IV.—OF THE PERICHONDRIUM.

The perichondrium is a fibrous membrane which covers the non-articulating cartilages; it is less intimately connected with these than the periosteum is with the bone; it sends but few fibrous prolongations into the interior of the cartilages. It is not very vascular. The vitality of the perichondrium is inferior to that of the periosteum; in other respects it resembles this latter membrane.

### § V.—OF THE FIBROUS ENVELOPES OF THE CEREBRO-SPINAL NERVOUS MASSES, AND OF SOME OTHER ORGANS.

These membranes are:

1st. *the dura mater (meninge de Chaussier)*, situated in the cranium and spinal canal, lining, as an internal periosteum, the cavity of the former, and, connected very intimately to the arachnoid membrane covering the brain, the cerebellum, the medulla oblongata, and the spinal marrow, slightly elongated in the form of a sheath over the nerves

which take their exit from the base of the cranium, pierced with foramina for the passage of these nerves and of those of the spinal column; lastly, forming several folds which ought to be divided into those which separate the various parts of the encephalon, which are the folds of the cerebrum and cerebellum, the tentorium of the latter; and into those which supply the place of venous canals, and are lined by the internal membrane of the tissue of this name: these are the sinuses of the dura mater. The latter are, according to some authors, composed in infancy of two layers; its fibres are very distinct, its vascularity is equal to that of the periosteum*.

2nd. *the sclerotic,* is a very firm fibrous capsule which serves as a covering to the eye, determines the form of that organ, and protects its other parts. Its fibres are very indistinct, and it possesses but little vascularity.

3rd. *the albugineal,* which surrounds the testicle, sends off from it prolongations; equals in its thickness the two preceding, and possesses, like the latter, but little vascularity. We shall consider this membrane as the covering of the ovaries.

4th. and lastly, the *fibrous tunic of the kidneys,* which sends off also prolongations into the interior of those organs.

It is necessary to observe, that any parts to which the non-elastic fibrous tissue affords a covering, are not destined to

* Many anatomists class also in this fibrous tissue the cellular vascular covering of the nerves (the neurilima), which possesses, in fact, in many places, a thickness which justifies this opinion; but the neurilima resembles rather the pia mater than the fibrous envelope now considered: at least it is contiguous with the former at the origin of the nerves.

sustain sudden changes in volume. We shall presently notice that those in the contrary case are surrounded by an elastic fibrous tissue.

### § VI.—OF THE FIBRO-SEROUS AND FIBRO-MUCOUS MEMBRANES.

Wherever the fibrous membranes are found connected with the serous or mucous membranes, they unite so intimately together that it is impossible to separate them by dissection; so that they appear to form but one membrane, fibrous on their external surface, and mucous or serous on their internal. The pericardium and vaginal tunics are, in a part of their extent, true sero-fibrous membranes; the union of the dura mater and the arachnoid membrane is equally intimate in all those places where these envelopes are placed one above the other. We find examples of the fibro-mucous membranes in the wind-pipe; the fibrous tunic which unites the arches of this tube is inseparable from the mucous which lines it; the periosteum and perichondrium present the same thing wherever the internal integuments lay immediately over them, as is seen in the nasal fossæ, the auditory canal, the larynx, &c.

## SECOND DIVISION.

### OF THE YELLOW OR ELASTIC FIBROUS SYSTEM.

*Definition.*—This system includes a great number of membranous and ligamentous parts, &c. composed of a tissue analogous to the preceding as regards its texture, but which is distinguished from it by a very remarkable elasticity.

*Situation.*—We find this tissue present wherever a continued or occasional resistance to weight, force, to that of the muscles, &c. is required. The principal organs, or the portion of organs which make up this tissue in man, are—the yellow ligaments of the vertebræ, the proper membrane of vessels, especially of the arteries, the excretory and air passages, the covering of the spleen, that of the cavernous bodies, &c.*

*Conformation.*—The elastic fibrous tissue is met with under three forms; namely, 1st. that of bundles (in the yellow ligaments); 2nd. that of tubes (in the vessels and the excretory canals); and 3rdly, that of a membranous sac with internal reticulated prolongatious (as in the covering of cavernous bodies and of the spleen).

*Structure.*—This tissue is formed of fibres placed in bundles, parallel or a little oblique one to the other, but never

* Among animals, this constitutes the posterior cervical ligament, and is also the basis of what are termed claws among those species of animals *cats.*

crossed, and easy to separate; it possesses but a small quantity of cellular tissue and few vessels.

*Physical and chemical characters and properties.*—This tissue is of a slightly yellowish white during life, more so after death; it is opaque, firm, more tenacious and much more elastic than the other fibrous tissues; more tenacious after death, and less so during life, than the muscular tissue, which it resembles more than the preceding. The most remarkable physical property is its elasticity, by which it readily resumes its previous form after it has been distended or compressed. This property is owing to the large quantity of water it contains; so that, when it is deprived of this by being dried, it loses half its weight, and has a horny appearance. But it is only necessary to moisten it again for a certain time, in order to restore its elasticity and principal characters.

It resists for a long time maceration; boiling water, acids, and alkalies, have very little action upon it. Decoction does not convert it into gelatine like the latter. This principle enters indeed very partially into its composition; but, instead of that, albumen and fibrine abound.

*Vital properties.*—This tissue manifests neither sensibility nor contractility.

*Functions.*—It furnishes bounds or envelops to certain parts, accommodates itself, by its extensibility, to their changes in form or volume, and restores them, by its elasticity, to their original situation, when the cause of these effects cease.

### MORBID ANATOMY.

The anatomical history of diseases of this tissue is included in that of the fibrous (properly so termed). We shall only observe, that ossification is more rare in this than the latter; and that it loses its elasticity after a too frequent, excessive, or prolonged distension.

## THIRD DIVISION.

### OF THE FIBRO-CARTILAGINOUS SYSTEM.

We include in this system those parts which, by their texture and tenacity, partake of the characters of the fibrous tissue, and, by their density and whiteness, those of the cartilaginous*.

*Division.*—We divide the fibro-cartilaginous organs—1st. into those which are free on both their surfaces, as the inter-articulating (or *menisques*); 2nd. into those which have one surface free and the other adherent, as in tendinous sheaths and those surrounding the articulating cavities; 3rd. into those which adhere by both their surfaces to bones, to which they serve as points of union.

*Situation, form, and kind.*—1st. the inter-articulating fibro-cartilages are found in the knee-joints, in the inferior maxilla, and the clavicle. They are lamellated, free on both surfaces, adhering by their extremities to the capsules or articulating cartilages, sufficiently moveable to accommodate their actions to the articulations: 2nd. the fibro-cartilages adherent by one of their surfaces are of two kinds; that is (*a*), those of tendinous sheaths, placed where the tendons

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* Bichât places in this system membraniform cartilages, which Meckel, Béclard, and other anatomists, regard as true cartilages. It will be seen, in the following chapter, that this latter mode of classing them is preferable to that adopted by Bichât.

pass over the bones, resembling grooves (*b*); those in the form of depressions, which line the glenoid and condyloid cavities: 3rd. the fibro-cartilages adherent by both their surfaces are found between osseous portions, to which they serve as bonds of union; their form corresponds to that of its surfaces; thus, those which unite the bodies of the vertebræ together are circular; that which is found at the symphysis pubis resembles very much an oblong square, &c.

*Structure.*—The fibro-cartilaginous tissues are not combined in the same proportions, nor disposed in the same way, in all the parts of this system.

It is thus that the fibrous substance predominates in the inter-vertebral ligaments, where it forms concentric layers; it is less abundant in the cavities which surround certain articulations (here the fibres are circular), and still less so in the inter-articulating fibro-cartilages, and often very indistinct in the sheaths of tendons, which are formed from the periosteum, converted, almost entirely into cartilage.

In general, the fibrous substance is much more apparent, when we examine the fibro-cartilage near its external part, at which place it exists almost alone; on the contrary, the cartilaginous substance will be found more abundant the nearer we approach the centre of the organ, where the fibres disappear. In some places we find alternately a fibrous, then a cartilaginous layer. This system is but slightly vascular, similar to the two tissues of which it is composed.

*Physical and chemical characters and properties.*—The fibro-cartilages are whitish. They unite to the tenacity of the fibrous system, from which they also derive a portion of their suppleness, the elasticity of cartilage. It is also to be

remarked, that, during pregnancy, the fibro-cartilages which unite the bones of the pelvis sensibly soften and become more moist. Boiling reduces this tissue into gelatine.

*Vital properties.*—These organs manifest neither sensibility nor contractility in the healthy state.

*Varieties according to age.*—The homogeneous part of the fibro-cartilages predominates in infancy; they are then very soft; in proportion as their consistence increases, their fibres become more and more apparent. Ossification in advanced age is very rare.

*Functions.*—The fibro-cartilaginous organs have different uses, according to their nature: some facilitate the movements of certain tendons, to which they offer a point of insertion at once solid and elastic; others assist in the motion of articulating surfaces, between which they are situated, either as species of cushions, or as equally elastic ligaments.

## MORBID ANATOMY.

In consequence of the little vitality the fibro-cartilages possess, their diseases are very rare; cicatrization of their wounds is very slow. Inflammation exhibits also the same character; it gives to the inflamed parts a reddish colour, sometimes uniform, at other times striated, and which often passes to a brown; it frequently softens them: sometimes suppuration supervenes; when it does, the matter is very thin and bloody, deposes itself in several parts in the substance of the fibro-cartilages, or becomes absorbed from without. Ulceration of these latter has frequently occurred.

We find, among those subject to rickets and diseases of the spine, the inter-vertebral fibro-cartilages softened, swelled, and gorged with fluids. This tissue becomes easily ossified under the influence of an irritating cause. Among the adventitious fibro-cartilaginous productions which we meet with in the body, we shall notice those which are developed in the fibrous tissue in consequence of accidental friction, and those which we meet with in some cysts, or in the centre of certain tumours, in some cicatrices, as those, for example, which succeed in the lungs after the bursting of tubercles; lastly, in several anomalous fibrous bodies: Meckel has even classed these latter among the fibro-cartilaginous productions.

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There have been but a very few works written expressly on the different parts of the fibrous system. We consider it our duty to refer the reader to the general treatises already alluded to, and to recommend to him particularly the perusal of those excellent articles by Béclard on the fibro-elastic tissue, in the appendix to Bichât's *General Anatomy*, and in his own work on the Vessels, chap. viii, p. 323 and following. We also recommend the works of Dr. Gendrin, p. 322, on the *Anatomical History of Inflammations*, and the articles by M. Laennec to be found in the fifteenth volume of the *Dictionary of Medical Science*, as containing much information on the morbid anatomy of the fibrous and fibro-cartilaginous systems.

# CHAP. V.

# CARTILAGINOUS SYSTEM.

## SECTION I.

### GENERAL CONSIDERATIONS.

*Definition.*—The organs, or the cartilages, which compose this system, are hard parts, without any apparent texture or organization; they are whitish, brittle, slightly flexible, and elastic, independent of each other, and are generally connected with the osseous system.

*Division.*—Cartilages are divided into the temporary and permanent. The former being only those merely destined to become osseous, and which pass insensibly through various states; one of these is the cartilaginous, the history of which we shall refer to the osseous system in the next chapter. The latter are not all permanent, strictly speaking; for several of them become ossified at a greater or less period of time. We shall divide them into two principal classes: the first will comprise those cartilages which have no perichondrium, the articulating alone; the second class will include all those which are provided with it; as the cartilages of the ribs, the larynx, membranous parts, &c.

*Form and characters.*—Cartilaginous organs present a great variety of form. Some are long and narrow, others are

extended as species of membranes; all being more or less flattened. We shall enter more fully into this subject in the following sections.

The cartilages of the first class are united to the articulating extremities of the bones, either by both their surfaces (as in the immoveable articulations), or by one surface alone (as in the moveable articulations). Those of the second class adhere to the bones, as in the ribs, those of the ear, nose, &c., or are connected with the soft parts, as in the larynx, &c.

*Texture.*—The cartilaginous tissue appears at first to be homogeneous; but a more minute examination proves it to possess fibres, the direction of which vary in the two classes, as we shall notice in describing the history of each.

Long-continued maceration reduces this tissue into a very condensed cellular mass. It does not appear to have any vessels; unless we consider as such those yellow and sometimes reddish striæ, which in many cases are observed in it. However, the cartilages are imbued with the fluids of the system. This fact, which their nutrition supposes, is ascertained by the yellow colour they assume when affected in jaundice. No nerves have as yet been discovered in it.

*Physical and chemical characters and properties.*—Cartilages appear of a pearly whitish colour: when cut into thin lamina, they exhibit the semi-transparence of horn; the osseous tissue is the only one which exceeds this in firmness and density*. They may, however, be divided with the scalpel. These organs are very elastic; but cannot be greatly extended without rupturing them. They contain a great deal of

* Still the bones only possess externally this latter kind of superiority.

water; when dried, they become transparent and yellowish, but a short maceration in water soon restores their original aspect: they are decomposed very slowly; a long time is also required to macerate them. When boiled, they become crisp; the articulating cartilages alone are then dissolved, and yield a kind of jelly; the others remain insoluble, and do not furnish gelatine, unless a portion of them become ossified.

Chemical analysis has discovered nothing certain as yet respecting the cartilages in man. They are composed, according to MM. Hatchett and Davy, of albumen and phosphate of lime, and, according to M. Allen, of albumen and a little carbonate of lime. M. Gendrin regards the gelatinous substance obtained by the boiling of articulating cartilages as a compound of albumen, of animal mucus, and of phosphate of lime; according to this author, the cartilages of the larynx also contain gelatine, formed chiefly by the fibrine combined with water.

*Vital properties.*—The vitality of the cartilages is very obscure; their nutrition is supplied with an extreme tardiness, except at the time of puberty, when those of the larynx are rapidly developed in a very remarkable manner. We cannot refer to the sensibility of these organs, those pains which are occasioned by the presence of foreign bodies in the articulations.

*Varieties from age.*—Cartilages possess at first the consistence and appearance of a thick mucilage: they afterwards acquire, very gradually, until the adult age, the degree of solidity under which we recognize them.

This latter period is when they possess the greatest elasticity; a property, the condition of which is in the intermedi-

ate state to that of their greatest rigidity and to that of their primitive softness. In advanced age they become drier, more coloured, and opaque; the calcareous matter accumulates in them, and ultimately they ossify, at least partially so. The cartilages of the moveable joints are alone exempt from that change* which sometimes attacks the others at a very early period.

*Functions.*—Cartilages possess, in consequence of their hardness and elasticity, functions which vary too much, and those depending on the classes to which these organs belong, to be specified in this section, but which may all be compared, in a general manner, to that of elastic springs.

### MORBID ANATOMY.

When cartilages are divided without any loss of substance, the surfaces of the solution of continuity remain in juxtaposition; but adhesion does not take place, and the perichondrium alone, when it exists, cicatrizes, and forms an osseous deposit which surrounds the wound. Separated from the adjoining parts, they do not afterwards unite. Their inflammation is not well marked: we may notice, as the results of that morbid state, those ulcerations which they sometimes present; the tumefaction, with softening, and the morbid fatty condition which they assume, especially in some diseases of the joints. We shall return to these alterations in the two following sections of this chapter.

We sometimes meet with cartilages accidentally developed in the system. M. Laennec has divided them into the *com-*

* It is, however, observed in a very limited number of cases.

*plete* and *incomplete;* a division which Meckel rejects, relying on observations made at different periods on the developement of similar products. Accidental cartilages are found in the form of plates in the substance of the arterial coats, in the sub-serous tissue of the spleen, of the lungs, of the testicle, &c.; in irregular masses in the substance of some organs, as in the thyroid cartilage, the ovaries, &c.; lastly, in some fatty scirrhus tumours, under the form of little flattened bodies, attached or free to the external or internal of the synovial membranes, but rarely of the serous. The urethra, the vagina, the prepuce, are sometimes the seat of a cartilaginous change; even bones themselves are sometimes, though very rarely, affected.

## SECTION II.

### ARTICULATING CARTILAGES.

*Definition.*—This name is given to those cartilages which cover the articulating extremities of bones.

*Division.*—We shall distinguish the cartilages of the moveable articulations, or the diarthrodial cartilages, from those of the immoveable articulations, or the synarthrodial.

*Form and kind* (*a*).—The diarthrodial cartilages present the appearance of flattened plates, thinner at the circumference than at the centre of their convex articulating extremities, thicker, on the contrary, at their edges than at their centre, over the concave articulating extremities; spread over the diarthrodial osseous surfaces, which they cover in their whole extent, and to which they very intimately adhere by one of their surfaces, whilst the other is lined by the synovial capsule, which separates it from the corresponding surface of the opposite articulating cartilage (*b*). In the immoveable articulations, we find, between the osseous extremities, lamellated cartilages adhering to the bone by both their surfaces, and to the periosteum by their extremities*.

*Texture.*—By maceration, boiling, &c. the fibres of which

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* The synarthrodial cartilages of the bones of the cranium are thicker on the convex than on the concave surface; the sutures also disappear sooner on the interior than on the exterior of this bony case.

this tissue is composed are seen of an homogeneous appearance in the articulating cartilages. These fibres are placed perpendicularly to the osseous surface they cover, and to which they are very intimately united: those of the diarthrodial cartilages appear to soften at their free extremity; in that place, the cellular tissue which enters into their composition is modified, and forms a part of the synovial capsule which lines the cartilage. We cannot trace at all the vessels in these organs.

*Chemical characters.*—The articulating cartilages are those only which yield gelatine by decoction.

*Varieties from age.*—Besides what we have said upon this subject in the preceding section, we shall add, that the diarthrodial cartilages diminish considerably in old age; that they ossify much more rarely than any others; and that, on the contrary, those of the immoveable articulations belong as much to the class of temporary cartilages as to that of the permanent.

*Functions.*—The cartilages of the articulations diminish, in virtue of their elasticity, the effects of compression, and shocks which might injure the articulating surfaces; they facilitate, also, by means of the same property, the movements of the diarthrodial joints.

### MORBID ANATOMY.

Articulating cartilages are sometimes swollen and softened in inflammation of the joints. Their fibres often become apparent, as well on their internal as on their free surface, which is then similar to velvet. At other times, they are

detached from the bone, or destroyed by inflammation*. This morbid affection very rarely attacks them, especially the diarthrodial: it may terminate by suppuration, and produce ulceration. Sometimes the articulating cartilages are succeeded by a hard and ivory-like substance, which M. Meckel believes to be the urate of soda. The diarthrodial cartilages appear sometimes thinner in one or more places. M. Laennec attributes this phenomenon to the partial regeneration of a portion of cartilage destroyed by ulceration. The osseous or cartilaginous plates which are sometimes found implanted in the articulating cartilages are new productions, which, after being introduced into the joint, in crossing the synovial capsule, are imbedded in this cartilaginous substance. We find in those false unions which take place between the fragments of a fractured bone a tissue more or less resembling the diarthrodial cartilages, but which ought only to be considered as an imperfect callosity.

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* Their destruction is followed by the union of their osseous surfaces, which are then in contact—a union which constitutes true anchylosis.
(See Osseous System, Morbid Anatomy of the Articulations, p. 167.)

## SECTION III.

### PERICHONDRIAL CARTILAGES.

*Definition.*—We shall include in this class a certain number of cartilages which have for their common characters, the forming a portion or the whole of the apparatus of certain parts, in being covered with a fibrous membrane or perichondrium; and which do not yield gelatine by boiling.

The cartilages of this second class are: those of the ribs, the larynx, the auditory canal, the nasal partition, and those of the sides of the nose; the cartilages of the eyelids, the ear, the tongue, the epiglottis, the trachea, and bronchia, wrongly classed by Bichât among the number of the fibro-cartilages.

*Form and connections.*—Among these cartilages, some are membranous, as the thyroid, that of the lobe of the ear, &c.; others, as the ribs, have the form of narrow and rather thick portions; others again represent imperfect rings, as in the arches of the trachea and bronchia. Some are attached to the bones by their sides or extremities as firmly as the articulating cartilages (as in the ribs, the nasal partition); others are connected only with the soft parts (those of the larynx and trachea, the tarsal cartilages). There are some which are so connected as to move over each other, and which present articulating projections, united together by capsular ligaments: of this kind are the cartilages of the larynx. More minute details upon the form and connections of these organs belong to descriptive anatomy.

*Texture* (*a*).—The cartilages of the ribs are composed of elliptical laminæ, placed over each other, and united together by transverse fibres.

Herissant says that these laminæ have a spheroid form. However this may be, they appear fibrous when decomposed, and terminate by being resolved into cellular tissue; but it is necessary, in order to see the texture of these cartilages, to make them undergo a very long maceration, and then to dry them, or submit them to the action of acids. (*b*) The other cartilages of this class may be reduced by maceration and boiling, first into very tender and short fibres, then into cellular tissue. The cartilages of the eye-lids, of the ear, and all membranous fibro-cartilages of Bichât, have a less dense tissue, and resist less than that of the other cartilages, maceration, &c. They are covered with a thicker perichondrium, which sends fibrous prolongations into their internal parts; whilst the fibrous envelop of the preceding is only united to them by cellular tissue.

*Physical properties.*—These cartilages are more or less flexible (the membranous are more so than the others), and very elastic; they do not yield gelatine by decoction; they contain more earthy matter than the diarthrodial.

*Varieties from age.*—Some of the perichondrial cartilages, and especially those of the ribs, the larynx, and the wind pipe, after being developed until the adult age, like all the others, generally ossify, either wholly or partially, and assume in their central portion an areolar texture.

This adventitious change is accelerated in the cartilages of the ribs by pulmonary consumption, and in the larynx by laryngeal phthisis.

*Functions.*—The cartilages of which we are treating con-

stitute, either solely or with the bones, the basis of certain parts of the body; thus contributing to determine the form: in a word, they supply the place of bone in those parts where great expansive motions (as in respiration, &c.) require the presence of a more flexible or elastic apparatus.

### MORBID ANATOMY.

The form of the perichondrial cartilages may be altered by any mechanical power; it is thus that tumours of the neck, as in goitres, give to the tracheal and bronchial arches a flattened or triangular form, by the compression which they exert upon them.

Solutions of continuity of the cartilages are not followed by cicatrization; but the perichondrium provides an osseous or cartilaginous ring, which surrounds the fragments and keeps them in contact. This mode of union is not so long when they are in contact at their extremities, as when they overlap each other. If ossification of the cartilage has already commenced, it may form between the ends of the fracture a true callosity. (See Osseous System, *Morbid Anatomy.*) Inflammation of these cartilages most commonly terminates in ossification.

The examples of caries and necrosis which are met with in cartilaginous organs, and especially in the larynx, attack those parts only which have undergone the osseous transformation.

Among the small number of congenital anomalies observed in these organs up to the present time, the absence of some of them has been noticed, and especially in the ribs.

### *Works consulted on this Subject.*

Besides the general treatises before mentioned:

*Herissant*—Sur la Structure des Cartilages dés Côtes de l'Homme, et du Cheval; dans Mem. de Paris 1748, p. 355.

*Delassonc*—Sur l'Organisation des Os; dans Mem. de Paris 1752, p. 253.

We shall find in this work some very interesting particuars upon the texture of articulating cartilages.

*J. G. Hossc*—De Fabrica Cartilaginum. Leipsig 1767.

*Docrner*—De Gravioribus quibusdam Cartilaginum mutationibus. Tubing 1798.

*Cruvcilheir*—Observations sur les Cartilages Diarthrodiaux et les Maladies des Articulations Diarthrodiales. *Archive Général de Méd.* Fevr. 1824, p. 161.

*Gendrin*—His. Anatom. des Inflammations, tom. 1st, p. 322.

# CHAP. VI.

# OF THE OSSEOUS SYSTEM.

## SECTION I.

## OF THE BONES.

### ARTICLE FIRST.

#### GENERAL CONSIDERATIONS.

*Definition.*—The osseous system is composed of a great number of organic pieces harder than all the other solids of the body, united mediately and in different ways one with the other, and forming a kind of apparatus which serves as the base of support to the other organs, and determines the general shape of the body.

*Situation.*—The bones are always situated in the midst of the soft parts under the integuments and muscles which cover them ; they are never found entirely externally.

*Division.*—In proportion as one or two of their dimensions predominate, or that the three are nearly equal, they are divided into the *long*, *flat*, and *short bones ;* there are also a *mixed kind*, or those which belong at the same time to two of the preceding classes. These not only differ from each other in their size, but also by other characters, which we shall presently describe.

*Form.*—As the osseous system presents in its assemblage the general appearance of the body, it was thought that the bones themselves should vary according to the different regions of this latter: it is this which indicates, likewise, the division which we are about to establish: we shall refer then this subject to the particular history of each kind; but it is here the place to notice those eminences and depressions which the surfaces of bones present, and which modify their conformation.

1st. *The eminences* or *projections* are either articulating, or non-articulating; the former are surrounded by cartilaginous tissue, which we shall consider in the following section, on the subject of the articulations. The latter, destined chiefly for the insertion of fibrous parts, are deprived of cartilages, and are more or less rugged. The variety of forms which these eminences present, have given rise to their division into several *species*, designated by the generic names of *apophyses*, of *processes*, of *branches*, when they are very long and projecting; by those of *protuberances*, and *tuberosities*, when they are very short and thick; by that of *crests*, when they are very pointing, narrow, and extended; of *spines*, when they are small, thin, and sharp; of *lines*, when they are long and slightly projecting.

2nd. *The depressions* or *cavities* are divided also into articulating, and non-articulating; the first alone are, like the corresponding eminences, surrounded by cartilage (see the history of the articulations). The second, which we shall consider here, are external or internal. The external cavities are sometimes only depressions or hollows; at other times they constitute true cavities. The form of each varies much: thus, some cavities, though very shallow, have

a large and widened entrance ; and are called *fossæ, digital impressions*, &c.

Other cavities, somewhat deeper, are narrow at their origin, and broad in the remainder of their extent ; they are lined by a mucous membrane, and filled with atmospheric air ; they are named *cells* or *sinuses*, according to their number and capacity, which are in an inverse proportion ; the former or *cells*, predominating in number, and the latter or *sinuses*, in capacity. A third class comprises under the names of *furrows, gutters, grooves, slopes*, &c. depressions more or less narrow and elongated, which receive generally vessels or nerves ; lastly, in a fourth class are included the *trunks, fissures*, and *canals*—cavities which run throughout the bones, and are more especially destined for the passage of vessels and nerves.

The osseous eminences and cavities are formed sometimes by a single bone, but more frequently by the union of two or more of these organs. We also meet with at the extremities, or on the surface of certain bones, small rough points destined for the insertion of the fibrous parts. Besides the cavities which communicate with the exterior of bones, there are others situated internally, which alter considerably the internal conformation of these organs.

These are simple openings in the form of canals in the body of long bones ; very numerous and similar to cells more or less large, in all the other parts of the osseous system. These canals, which result from the texture of these organs, are always more developed at the centre than on the external portions of bones ; they contain the medullary or fatty system.

*Texture.*—The tissue of the bones is fibro-laminous ;

very compact on their external surface; more areolated internally—a difference which proves in them a substance or *compact tissue, a reticulated, and a spongy tissue.* In the former, which always surrounds the other two, the fibres and the lamellæ are so closely connected together, as to give to the bone a fibrous appearance. The fibres, very irregularly distributed, and leaving only extremely minute spaces between them, appear like little canals, composed of plates and layers, united together by transverse or oblique fibrillæ. The *reticulated tissue* is less compact, and constitutes, in some degree, the most internal layers of the preceding. In the *spongy tissue,* the fibres and laminæ leave spaces or areolæ similar to those of sponges, or to those of the emphysematous cellular tissue (with this difference, that they are filled with fat). These belong to the second order of those osseous canals to be presently noticed.

According to late analysis, the osseous system is a kind of cellular tissue, hardened by being combined with a gelatinous calcareous substance, but which has preserved the internal forms of its primitive condition, even to the fat deposited in its cells.

There also enters into the structure of bone other parts as well as the osseous tissue: these are—1st. a fibrous envelop which serves them as an external covering, and which has been already described under the name of *periosteum* (see p. 106); 2nd. the marrow, or the adipous system of bones, which occupies the cells of the spongy and reticulated substances, and even the minute interspaces of the compact tissue, and also the great internal canal of the long bones, which we shall presently see is enclosed in a vasculo-cellular membrane peculiar to itself. The fat

of bones is contained, if not every where, at least in the most extensive of its interstices, in little vesicles filled with an oily substance, more liquid and yellow than in that of the general adipous tissue; but we shall not enlarge on a subject which has been treated of before (see chapter on the Adipous Tissue); 3rd. of blood-vessels, divided by anatomists into three orders; the first comprehends those minute arteries which, arising from the vascular net-work of the periosteum, penetrate the compact substance by extremely minute orifices. The second series is composed of vessels which enter the spongy substance through larger foramina, and are seen both at the extremities of the long and short bones. Lastly, in the third are found vessels known more particularly by the name of nutritive, which traverse, without ramifying, hollow canals formed in the compact substance, and which go to the medullary membrane. The corresponding veins to the arteries of the two first orders do not pass out of the openings which receive these latter; on the contrary, the arteries of the third series are accompanied in the nutritive canal by a number of corresponding veins; that is, with one of each in the generality of cases. The veins belonging to the compact and spongy tissues are composed only of the internal membrane of the venous system. They present a cellular disposition, which establishes a relation between them and those which constitute the erectile tissue of cavernous bodies, &c. They are also formed like the latter, by the internal membrane only of the venous system; a character which equally belongs to the small veins of the compact substance. We cannot trace lymphatic vessels beyond the surface of bones. Nervous filaments accompany the vessels of the medullary membrane

of long bones; but we cannot discover any in the osseous system.

*Physical and chemical characters and properties.*—Bones are of a yellowish white colour; their density varies, as we have seen; they are very hard, resisting, yet slightly flexible and elastic; susceptible of a gradual extension; but resuming their original dimensions when that cause is suppressed. (Certain osseous cavities, as the nasal fossæ, the orbit, &c. temporary enlarged by swellings, return to their natural capacity after these have subsided.) The solidity or hardness of bones depends on their chemical composition.

From the analysis, of well dried bones, M. Berzelius obtained the following principles: an animal matter reducible to gelatine by decoction, 32,17; an insoluble animal substance, 1,13; phosphate of lime, 11,30; carbonate of lime, 2,0; phosphate of magnesia, 1,16; soda, and the hydro-chlorate of soda, 1,20. The analyses of Fourcroy and Vauquelin differ slightly from this: these chemists having discovered in bones the presence of iron and silica. As for the other parts, the composition of bones varies according to those examined, and to the age of the individual to whom they belong; also to the state of health or disease of the subject. The gelatinous portion may be separated by decoctions, and the saline part decomposed by acids.

*Vital properties.*—Bones are insensible in a healthy state; they never manifest vital contractions. The length of time required for their formation and reparation proves they possess an obscure vitality.

*Mode of development and varieties from age.*—Bones, at first a fluid, like all the other tissues, then gelatinous, after-

wards pass successively (at least among a great number of them) through the fibro-cartilaginous and cartilaginous states; in which state they remain among certain vertebrated animals, and which in man, is succeeded, after a very variable period, by the osseous condition, as we have already described. At the commencement of the fœtal life, this system, being of a mucous consistence, forms a continued whole, but afterwards is divided into a great many parts. Ossification commences about a month after conception, and is not completed until twelve years, and even eighteen are required for some particular parts. It does not appear to be every where preceded by the cartilaginous state.

Howship has seen some parts of this system, as those in the body of the long bones, and the large bones of the cranium, pass at once from the mucous to the osseous state. As to bones which are cartilaginous before they become ossified, their transformation is thus accomplished. In the centre of the temporary cartilage formed in the first two months, and which already presents the shape of the bone, appear canals and vessels, lined by a vascular membrane, filled by a fluid, at first viscous, then bloody. The appearance of this latter is soon followed by that of the first osseous deposit*. The cartilage may then be seen injected with

* Every natural or accidental ossification is made known by the developement of a little vascular point, red in that part of the fibro-cartilage, or of the cartilage about to be changed. From the moment that this has taken place upon one point (always in the centre of the body), the formation of vessels, or at least their developement and colour, continue to precede it, and in such a way that the ossified portion, and that which is not yet so, are always separated by another portion injected with a red colour.

red particles around the transformed part, assuming its homogeneous appearance in proportion as we examine nearer to its centre. Ossification thus gradually extends itself from within to without, and terminates by supplying the place of the cartilages.

The canals of which we have spoken, at first very large, progressively diminish when the process is completed. We then find, instead of the homogeneous substance of the temporary cartilage, a bone with distinct fibres, and supplied with vessels. A variety of hypotheses have been framed to account for the change of the cartilaginous tissue into the osseous; but the real nature of this nutritive phenomenon is still as concealed from us as all the others: we ought then to confine ourselves, to observe in that transformation the result of a change of nutrition in the cellular texture, in consequence of the influx of blood into the cartilage,—a change in virtue of which a tissue, composed of gelatino-calcareous fibres, succeeds to an homogeneous albuminous substance.

A great number of bones are formed from various points of ossification. It is thus sometimes the two symmetrical halves of a single bone are developed separately, and the process completed by their meeting and uniting together on the median line: as in the frontal, and inferior maxillary. Other symmetrical bones have middle and lateral points of ossification; as in the sphenoid, the vertebræ, &c. Non-symmetrical bones differ from each other, both as to the number and particular form of their primitive osseous points.

The point of union in parts originally distinct in the same bone sometimes remains during life: this may be observed in the sacrum.

Many articulating and non-articulating eminences are

formed by distinct points of ossification, which appear at very different periods; that is, from fifteen days before birth even to fifteen or eighteen years after.

These osseous points are termed epiphyses, so long as they are separated from the bone by a cartilaginous portion, which, by becoming ossified, converts them into apophyses. It has been attempted to ascertain, in a general manner, the order in which ossification takes place in the different parts of the skeleton; but these enquiries do not coincide with all the facts. The two following are those which present the fewest exceptions: 1st. bones become developed in man in a similar order to their appearance among the different classes of animals; 2nd. long bones are formed before flat bones, and these latter before short bones*.

At the time of their formation, the bones approximate, as

* The following is the order in which different parts of the skeleton become ossified. The difficulty of establishing general rules on this subject will be perceived after reading these details. Ossification commences about the end of the first month in the clavicle; and successively in the inferior maxillary, the femur, the tibia, the humerus, the superior maxillary, and in the bones of the fore-arm, about thirty-five days. It commences in about forty days in the fibula, the scapula, the palatine bones; and the following days in the centre of the occipital bone, the frontal, in the ridges of the first vertebræ, in the ribs, in the great wing of the sphenoid, in the zygomatic apophysis, in the phalanges of the fingers, in the bodies of the middle vertebræ, in the nasal bones, and zygomatic processes, in the ilium, in the metacarpal bones, in the phalanges of the toes. In the condyles of the occipital, and then in its basilar portion, in the squamous portion of the temporal, in the parietal, and in the vomer, in all of which bones ossification commences about the middle of the sixth week. In the course of the seventh week it commences in the orbital plate of the sphenoid, and, towards the end, in the metatarsal bones, in the phalanges of the toes and fingers. About

already noticed, both within and without, by the addition of a new osseous deposit around that part which has first appeared; besides which, the periosteum, more vascular at the period of ossification than at any other, secretes and deposes, it is said, on its internal surface, osseous particles, which become united to the bone, and increase still more its thickness*. It is then, by a kind of juxta-position, that the

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two months it commences in the body of the sphenoid; in that of the first sacral vertebræ, and in the centre of the tympauum. At two months and a half, it is completed in the spinous process of the seventh vertebræ; before the close of the third month, in the labyriuth; and, at the end, iu the ischium, and in the internal pterygoid plate. Towards the middle of the fourth month, in the bones of the tympauum; in the middle month, in the pubis, in the os calcis, in the phalanges of the toes, in the lateral plates of the œthmoid, and iu the sides of the nose; a little later, in the superior portion of the sternum; about six months, in the body, and odontoid process of the second vertebræ, and in the lateral and anterior portions of the pelvic or sacral vertebræ; still later, iu the astragulus; about seven months, in the sphenoidal sinuses; later, in the crista galli of the œthmoid bone, in the cuboid, the first vertebræ of the coccygis; and at the anterior arch of the atlas, near birth: a year later, in the coracoid process, and in the great and little bones of the carpus; iu the first cuneiform, in the knee-pan, and os pyramidale, towards three years; about four years, in the second and third cuneiform bones; about five years, in the scaphoid of the tarsus, the trapezius, and semilunar; near eight years, in the scaphoid of the carpus; a year later, in the trapezius; and, lastly, in the os pisiforme, about twelve years.—Béclard, Anatom. Général, p. 496.

* The depressions and cavities of bones are formed at the time of ossification, either by the presence of some organ upon which the bone is modelled, or by an active pressure which opposes the growth in the parts where it is placed. They are not at all hollowed in the osseous system, as might at first be thought. The bones of the head are shaped by the brain, the articulating surfaces by the eminences which they receive, &c.

first developement in bones takes place; but, when once formed, they increase by an interstitial nutrition, less and less active, and which, at a certain age (near that period when the epiphyses, completely ossified, are united to their respective bones) is nothing more than a nutrition in reserve*. The nutritive process continues to diminish towards manhood: the number and size of the vessels decrease; the bones, less supplied by blood, become more earthy, more dry; they lose the degree of elasticity they possessed, and become thinner; from whence arises an evident enlargement of their internal cavities, and the fragility they acquire in old age. Among women, bones preserve their original characters for a longer period than in men.

* The knowledge of the property which the madder-root possesses of reddening the bones of animals fed upon it, has led several philosophers to study the mode of nutrition and growth of bones by experiments with this plant. Those made by Duhamel are the most interesting: the results are here stated. In young animals fed with this root, their bones soon become coloured; in old animals, on the contrary, it requires a long continuance of this root to procure a colour at all perceptible. If a young animal, after being fed for any time on the madder-root, has its use discontinued, and then repeated, and again omitted, the bones alternately present coloured and colourless layers; which proves a juxtaposition, and not an interstitial nutrition. It is probable that, after union of the apophyses, the same results might not be obtained. However, Duhamel did not admit that arrangement, but thought that the bones increased in length and width by extension. To refute this opinion, John Hunter relates the following experiment made by himself. Having perforated both the extremities of the body of a long bone in a young animal, and killed it some time afterwards, that anatomist found the distance which separated the two holes was the same as at the commencement of the operation; consequently, that the bone had not suffered extension.

*Functions.*—The bones are the passive organs of motion. Some form levers, to assist the muscles in their action; others give attachment to these latter, and serve as points of insertion to them. They protect, besides, important parts around which they are placed; such is the use of those which form the cranium, the spinal column, the thoracic parietes, and the pelvis: they throughout support the soft parts.

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## SECOND ARTICLE.

### OF THE LONG, FLAT, SHORT, AND MIXED BONES.

### § 1.—LONG BONES.

*Definition.*—By long bones, are meant those elongated osseous portions which have a medullary canal*, as the humerus, the cubit, the radius, the femur, tibia, fibula, the metacarpal bones, the metatarsal bones, and phalanges of the fingers and toes.

*Situation.*—All long bones are situated in the extremities, the whole extent of which they occupy, with the exception of the carpal and tarsal portions.

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* It is from this character that the generic name of bones should be drawn; the other mode is too general, and is also applicable to those which have no medullary canal, as the ribs, &c.

*Form and kind.*—They are thick and bulky at their extremities, where are found the apophyses for insertion, articulating cavities, and eminences; the bones then gradually decrease, and assume an imperfect cylindrical and triangular shape. That part intermediate to the extremities is termed their body, or diaphysis. There are also seen lines for muscular insertions, most frequently to the amount of three, and situated obliquely, so as to give the bone the appearance of being twisted.

Long bones represent, in their assemblage in each limb, an interrupted column, the pieces of which, articulated in different ways, as we shall presently see, diminish in size, and increase in number, in proportion as they diverge from the trunk.

*Structure.*—There exists a great difference in the internal form, between the body and extremities of long bones. The former is composed of a compact substance, which becomes thinner and reticulated towards the centre of the bone; where there is found a canal lined by a vasculo-cellular membrane, which sends into the interior of this latter a great many prolongations, sustained in some points by other prolongations, arising from the osseous substance, and which form, by their union, cells; in the interior of which, are deposed fatty vesicles, or, more properly, the marrow*.

The medullary membrane appears to be formed from a network of sanguineous and lymphatic vessels and nerves, supported by cellular tissue, arising from the sub-divisions of those which have entered the canal by the nutritive vessels.

* The medullary canal in birds is filled with air, which is derived immediately from the lungs.

This membrane is considered as the internal periosteum of the long bones. The quantity of marrow which the bone contains, and its consistence, are modified according to the external characters of the individual. It is very abundant and nearly aqueous in emaciated persons; on the contrary, its proportion is considerable among those who enjoy ordinary good health. Towards the extremities of bones, the compact substance is much thinner, and is then reduced to a plate which covers the mass of spongy substance, of which the extremities are composed; the medullary canal does not exist in these. Marrow is often found in the cells of their areolar substance, but without any distinct membrane.

*Physical characters and properties.*—Long bones unite, to the physical characters which are common to them, and the rest of the osseous system, the property of resisting greatly their rupture, by virtue of the compact texture of their body, and of the medullary canal which occupies their centre; so that there results from the existence of this latter a greater diameter in the bones without an increase in size or in weight.

*Vital properties.*—The osseous part of long bones presents nothing particular as respects its vitality; but the medullary membrane which lines its internal canal possesses a real sensibility; for if this membrane be irritated with a probe, after being sawn to the bone, the animal operated on experiences pain. It is also endowed with an obscure contractility similar to that of the cellular tissue.

*Mode of growth and varieties from age.*—Long bones are developed from three points of ossification; one for the body, and two for the extremities. The former appears before the others, about two months after conception, and with-

out passing through a cartilaginous state; it is at this time hollowed in its interior, where the principal nutritive artery already penetrates through the foramen of this name. Cartilages, possessing the form which the extremities of bones have, are added to the end of this cylinder; and, at the period of birth, ossification commences in the centre of these terminal points; from which result the epiphyses, which, as we have seen, remain for many years separated from the body of the bone by a cartilaginous portion. The increase in length takes place by the addition of the new substance to the extremities of the diaphysis, and by the union of the epiphyses to that central portion.

The medullary canal is at first only a narrow conduit, filled by the nutritive artery; when it enlarges, this latter remains united to its side; a soft viscous substance fills the canal; very soon the vasculo-cellular membrane becomes apparent; in the fœtus and the new-born child, it does not contain a true marrow, but a more watery fluid, and which acquires but gradually those qualities which have been noticed as belonging to the fat of bones. The medullary canal continues to increase with the age, and that without relation to the thickness of its parietes, since the bone grows from the exterior; but when that growth has ceased, these latter progressively become thinner, so that among old people they occupy a very limited place in the diameter of the body of the bone. In proportion as the canal increases, so does the quantity of marrow.

*Functions.*—Long bones serve in the locomotive apparatus the office of levers, which the muscles move with facility; they mutually offer points of support by their corresponding articulating surfaces.

## SECTION II.

### OF FLAT OR BROAD BONES.

*Definition.*—The class which we are about describing, is composed of pieces, whose capacities of length and breadth are nearly equal, and much superior to their thickness (the frontal and parietal, the shoulder bone, and the ilium).

*Situation.*—Flat bones form a part of the parietes of the cranium, the thorax, and pelvis.

*Conformation.*—They are lamellated, sometimes quadrilateral, sometimes semicircular, &c. more or less curved, or turbinated in various directions, so that the same surface may be entirely convex or concave, or alternately either; the opposite surface presenting the same conditions, but in a contrary sense to the former; that is, the one is concave in the part where the other is convex. Flat bones are thicker at their edges than in their centre; they also present inequalities of various kinds, more marked upon their articulating portions than upon those which give attachment to the muscles.

*Structure.*—Fat or broad bones are formed by the intervention of two plates or *tables* of compact substance; the internal table of the flat bones of the cranium, thinner and denser than the external, is, for this reason, called the vitreous plate. These tables are in contact in some places, especially in the centre of the bone; and separated in other parts, by a layer of spongy substance, which

has received the name of *diploe*. This latter is very vascular; possesses many large veins; and contains the marrow without a distinct membrane.

*Mode of developement and varieties from age.* — Flat bones are formed from two or more points of ossification. These show themselves at the end of the second month, in the mucous substance which exists between the periosteum and the dura mater in the bones of the cranium; and between the two laminæ of the former, in the others. The osseous nuclei are developed by radiating from the centre to the circumference, and form lastly, plates, which present radiated fibres, still separated by the mucous substance. Bichât remarks, that the origin of the sutures, by which several of these bones are united together, may be attributed to the interval which at this period the fibres of the flat bones leave between themselves. The plates which assist to form the same bone unite together. At a later period we may distinguish the two substances. The two tables, at first intimately united, become distinct as they acquire more density, and leave between them, as they separate, a spongy layer formed from the most internal fibres of their contiguous surface. In old age, that spongy part is absorbed, the two tables approximate, and the bones become thinner. It is to this phenomenon that we must attribute the subsidence of the parietal protrusions which are seen in advanced years.

*Functions.*—Flat bones, protect against external impressions, the organs contained in the cavities which they assist to form, and participate in locomotion, either in supplying simply to the muscles fixed and permanent points of insertion, or in executing the motions which these organs are destined to perform.

## SECTION III.

### OF THE SHORT BONES.

*Definition.*—Under this head are classed all bones whose three dimensions are nearly equal.

*Situation.*—These bones are situated in the spinal column, which is formed entirely by them, in the hand, the foot, &c. They are generally found together in a large number.

*Conformation.*—Their form varies too much to be described in a general manner. It is determined by the disposition of the part, to the structure of which they are adapted. They are sometimes globular, sometimes triangular, wedge-like, cuboid, &c. They have all depressions and projections more or less distinct, as well for articulation as for insertion.

*Structure.*—Short bones are formed externally of a layer of compact substance; internally they are of a spongy texture. They receive vessels, and contain the marrow without a distinct membrane, like all the other osseous parts which have no medullary canal.

*Mode of developement and varieties from age.*—Short bones pass from the mucous to the cartilaginous states, before they ossify. They possess in this latter state, both the form and size of their ultimate transformation; ossification commences from the centre to the circumference, dependent also on what we have elsewhere described; but it takes place very slowly. Certain short bones are formed in the substance or continuity of the tendons or ligaments, and pass

from the fibrous to the fibro-cartilaginous state; and, lastly, the osseous. The patella and all the sesamoid bones are of this nature; thus, they do not really form a part of the skeleton, and are for this reason considered as accidental bones.

*Functions.*—Nature has, throughout, placed the short bones where great solidity was required, with freedom of motion. It was necessary that they should be united together in great numbers to attain this double purpose, and that was to be accomplished at the expense of their size. Indeed, on the one hand it may be said, that any instrument whatever, formed of several pieces strongly united together, is more solid than another composed of a single piece, because the effects are lost in the points of union; and, on the other hand, the sum of the motions of a series of organs occupying a given space is relatively so much the more considerable, as these organs are more numerous and consequently smaller. The short bones of the vertebral column form besides, by their union, a sort of case for the spinal marrow, which is thus defended from external injuries.

## SECTION IV.

### OF THE MIXED BONES.

*Definition.*—Those bones are named mixed which possess the form and characters of the preceding species, and seem to result from the union of two or even of three of these latter (the sphenoid, the temporal, the occipital, œthmoid, ribs, sternum, &c. are of this kind).

*Situation.*—The greatest number are found in the head, and some in the thorax.

*Conformation.*—Their form varies very much, and is often dependent on the union of a large with a short and thick part.

*Structure.*—Each portion of the mixed bones presents the structure of the species of bone to which it is connected. It is in this class that is found the hardest and most compact portion of the skeleton, as the petrous portion of the temporal bone.

*Mode of developement.*—These bones are formed from several points of ossification, and present in each of their parts the mode of growth of the species peculiar to them.

*Functions.*—Mixed bones perform different functions in the animal economy: they assist in forming the cranium and the thoracic cavity: they surround and protect the organs which are found therein, the cephalic nerves, and some

of those of sensation, to which several of the latter belong: lastly, they give attachment to the muscles, the organs by which some among them are put into action.

### MORBID ANATOMY OF THE OSSEOUS SYSTEM.

Bones are subject to irregularities of conformation, which may be either congenital or accidental. The former are frequent in the bones of the cranium, less so in the thoracic and abdominal parietes, and rarely in the extremities. They consist either in a defect or an excess of growth in the osseous parts where they occur, and accompany most frequently congenital anomalies of the viscera which surround these parts. The irregularities of conformation consecutive to the development of bones depend sometimes on an accidental hypertrophy, or atrophy (this latter is frequenly observed in several chronic affections): at other times, they result from an inflammatory swelling of the periosteum, with the secretion, on the internal surface of that membrane, of an osseous substance, which afterwards unites itself to the bone, and constitutes *external exostosis.* This presents itself either under the form of a very circumscribed nodosity, from whence the name of node which is given to it, or under that of a tumour more or less extended, composed of large and superlatent layers.

We shall see, when we speak of inflammation of the bones, that that morbid condition may determine among them various kinds of deformities.

Solutions of continuity of bones or fractures, another kind of accidental lesion dependent on the conformation of these

organs, deserve a particular attention as regards their mode of cure. The opinions of the learned have, on this subject, varied considerably, as may be seen by the following exposition of the theories of callosity (cicatrix of bones) which have been advanced even to this day.

The ancients supposed that the portions of the fractured bone secreted at their extremities a viscous fluid, which they called the osseous juice, a coagulable lymph, a fluid which, gradually acquiring consistence, reunited them like a strong glue.

Haller further developed this theory, and published, that a juice, exhaled by the ends of the fractured fragments, and by the marrow, is effused around them, becomes mucous, cartilaginous, and, lastly, osseous; thus following all the changes of primitive ossification. Haller does not allow the periosteum to contribute at all to the formation of the callosity. J. Hunter regards this latter, as resulting from the organization of the blood effused round the fragments, and by its ossification. Latterly, Howship, who might already have known the ideas of M. Dupuytren, added to Hunter's theory—that the periosteum becomes cartilaginous at the end of the fragments, that the matter of the callus is deposed successively on the surface of the bone, then on the centre of the parts, lastly, in the medullary cavity; in fact, that the fractured portions are already firmly united to their external part before their ends are completely cicatrized. Duhamel's theory, published before that of Haller, maintained that the periosteum and the medullary membrane, and sometimes the first alone, extend and become united to those of the opposite fragment, and ossify so as to surround the fracture by an osseous ring, which is either single or double. This reunion,

the extremities of which were not themselves included, was regarded, according to Duhamel's opinion, as definitive. Bordenave, Bichât, and M. Richerand, believed that the fractured portions which are in contact become united by the growth of fleshy granulations at their extremities, which only takes place in compound fractures.

We are indebted to the works of MM. Dupuytren, Breschet, and Villerme, for a more accurate knowledge of what takes place in the osseous cicatrization. We shall find their ideas partly composed of those of Duhamel, Haller, and Howship.

According to the new theory of callosity, it may be divided into three periods of formation. In the first, the blood flows in small quantity, and insinuates itself between the broken fragments at the moment the fracture actually occurs, followed by the exhalation of serosity, rather viscous; the blood by degrees becomes colourless, the periosteum and the medullary membrane, and, lastly, the soft and separated parts, unite together. Then begins the second period, by the inflammatory swellings of these same parts, accompanied by the secretion of a coagulable matter into the substance of the periosteum, and between this latter and the bone. This matter ossifies very gradually: the same also takes place in the medullary membrane when it is affected in a long bone. Ossification extends without to the surrounding cellular tissue, even to the muscles. Lastly, there results from this process a *provisional callosity;* that is to say, an osseous incrustation on the surface of the extremities, still contiguous to the fragments: an incrustation similar to a ferrule or ring in many bones, and which is completed in long bones by the presence of a kind of osseous support in the me-

dullary cavity, in consequence of the ossification of the membrane of this name.

The provisional callosity is simply a retentive apparatus, not very solid, which serves merely to maintain the fragments in apposition. When it is formed, the third period commences, that of the definitive callus. Until now, the bone itself has not experienced any sensible changes; but at this period the substance effused between the fragments of bone acquires consistence; vessels are then developed, which communicate with those of the bone and periosteum; lastly, it ossifies, and thus firmly unites the two ends. When this process is completed, the provisional retentive apparatus is gradually absorbed, and finally disappears. The medullary canal is formed at the place of the fracture. When the fragments are not kept in their natural situations, so that they become displaced, yet still in contact, their medullary canal remains obliterated, and the external callus, at first merely provisional, becomes at last permanent. When the fractured portions are neither placed nor retained in contact, there is then formed between them a fibrous cicatrix. This generally happens after fractures of the patella, and at the neck of the femur, in consequence of the great difficulty of preventing the separation of the fragments. Sometimes their margins become globular, closed, and compact, surrounded even with a little cartilage, and covered with a synovial membrane. Hence arise imperfect articulations, which prevent, or impede at least, many of the motions of the injured part.

The epiphyses may be separated from the bone by mechanical causes, or by a morbid condition, as inflammation.

Reunion takes place here as in fractures. When these latter are comminuted, the disorganized part is supplied by an osseous effusion termed *callus*. Wounds of bones, when denuded, are generally followed by mortification, and with the loss of at least their external lamina; then by the formation of fleshy granulations, and lastly by their ultimate reparation*.

In general, wounds of bones, with loss of substance, require great energy for their reproduction. When an aneurismal tumour is in contact with a bone, it wears this latter by its pulsations; and may, when the bone is very thin, and the tumour enlarges, entirely perforate it.

After amputations, the extremity of the osseous portion of the stump inflames, is immediately united to the soft parts, becomes round and covered with a layer of compact substance, which closes the medullary canal.

If there has been a lesion of the bone or periosteum, beyond the end of the fragment, an osseous ring is formed round the latter, and the cure afterwards takes place as in ordinary cases. Inflammation is very rarely primitive in bones; but it sometimes extends itself from the neighbouring parts, and constantly follows their mechanical injuries. It is in these latter cases that we have studied among them the anatomical characters of this morbid condition. The osseous tissue, when inflamed, becomes swelled, more spongy, more heated, than in the natural state, and very much injected with blood.

* When the periosteum alone has been destroyed, the soft parts applied to the wound sometimes unite immediately to the bone without any exfoliation of the latter.

A gelatinous substance, or a reddish serum, fills up its areolæ. The calcareous salts of the bone are reabsorbed and disappear: the gelatine itself is evidently altered. The medullary canal disappears in the course of the disease. The membrane of this name, whose internal prolongations are red and thickened, are filled in their interstices with a fibrinous substance. Inflammation of bones often terminates in mortification or in *necrosis;* their compact portions are more particularly subject to this disease, in consequence of their possessing less vascularity. The affected part appears rugged, unequal, and brownish: sometimes, when mortification succeeds to gangrenous inflammation, the wound is spongy, brown, and exhales the characteristic fœtor of all gangrene. Most frequently the gelatine disappears; and sometimes the calcareous salts are decomposed. Hospital gangrene affects also the osseous tissue, and reduces it to a greyish and fetid mass.

Necrosis of the long bones presents some peculiarities important to be noticed, and affords a new example of the energy of reproduction in this tissue. When the body of one of these bones becomes partially or entirely mortified, there is formed around it another osseous portion, equal to the first, and pierced with many foramina, through which this latter may be felt by a probe, and its motion recognized in the interior of the new bone. The mortified or dead portion passes out naturally, or by the assistance of art, through these openings; after which they close. The newly formed part unites to the terminal portions of the bone which it succeeds, and finishes by surpassing the latter in density, and also in recovering its shape: the medullary canal and membrane likewise appear.

In those cases where the whole extent of the body of the bone is affected by necrosis, it is by means of the periosteum that reparation is accomplished: at other times, the internal plates alone being mortified, this latter consists only in a separation of the external plate, accompanied, as in all cases of new formation, with phenomena necessary for the expulsion of the morbid parts. The extremities of the long, large, and short bones are more affected by necrosis, and heal more slowly, than in the diaphyses or bodies.

*Caries*, or a softening with ulceration of bones, is another consequence of inflammation: the osseous tissue then acquires a softness, which allows them to be divided without any difficulty with the bistoury, and is also accompanied with great friability. A fetid ichor generally exudes from carious bones: when this discharge is very scanty, the disease is termed "*dry caries*"—a variety which is only seen in the flat bones, and in old age. This ulcerative inflammation attacks more particularly the spongy parts; short bones are also more subject to it than the others. When inflammation of the osseous tissue lasts for any length of time, we find this latter becomes swelled, composed of lamellæ and scattered fibres, containing in their interstices a thick and reddish matter, of an intermediate consistence to that of indurated cellular tissue and that of tubercles: a matter which is sometimes, at a later period, converted into fibro-cartilage, then into an osseous substance, to form a kind of *exostosis*, characterized by the simultaneousness of the swelling, and by the increased density of the bones. We find, in the exostoses which proceed from the bone itself, the characters which are common to a sub-acute inflammation of the osseous system, which proves that these tumours are the result of inflammation. It is very

probable that inflammation is the cause of *spina-ventosa*, or swelling with loss of substance in the bone, and also of *osteo-steatoma*, where tumefaction of the organ is united to a condensation of its tissue, and an alteration in its chemical composition.

Bones sometimes suffer from tuberculous, scirrhous, and cerebriform degenerations, &c. They are also subject to a remarkable softening, which arises from the absence or diminution of their earthy salts. When this affection accompanies their period of growth, it is termed *rachitis* or rickets: the bones are then reddish, spongy, and easy to divide with the knife. The parts naturally spongy are more rarefied and more bulky than the others; such are the extremities of the long bones, the largeness of which, at that time, gives rise to the opinion, among the vulgar, that the individual is rickety. This state is generally only temporary; but the bones preserve, in acquiring their natural density and solidity, those deviations and curves which the weight of the body and muscular action may have occasioned during their affection.

*Osteomalacy* is a softening, generally more considerable than the preceding, which sometimes supervenes after the cessation of the growth of bones. When the osseous system is at the same time softened and appears fleshly, the disease is then called *osteo-sarcoma*. In some cases, the bones are at the same time soft and very fragile: they then preserve their cellular texture.

All original and degenerated tissues may present accidental osseous productions. In the former, they generally result from advanced age. They are seldom exactly similar to the osseous tissue. These are sometimes incrustations

more calcareous than the latter, an example of which is met with in the arteries; at other times, it is a soft, chalky, and friable substance, composed of an animal matter and earthy salts, or even of an ivory substance (as in that which is found, in certain cases, instead of the diarthrodial cartilages). Fibro-cartilages and permanent cartilages put on, when they ossify, all the characters of the osseous system.

## SECTION II.

### OF THE DIFFERENT MODES OF UNION IN BONES, OR OF THEIR ARTICULATIONS.

Bones are united in such a way one with the other, as to form a whole, termed the skeleton; which presents the general shape of the body, and constitutes its base of support.

The union of two or more bones is called an *articulation.* We distinguish in every articulation, the articulating osseous parts, and their means of union.

The first offer, in general, inequalities which determine their motion or immobility, dependent on the kind of articulation.

Long bones are articulated by their extremities; flat bones by their edges, and short bones by various points on their surface. The bonds of union are cartilages, fibro-cartilages, or fibrous ligaments. The varied form of the articulating parts, the differences in their mode of union, and the motion, or immobility, which result from them, render it necessary to divide the articulations into the *synarthrodial,* or fixed; into *amphiarthrodial,* or fixed or moveable; and into *diarthrodial,* or contiguous and moveable.

1st. *The synarthrodial articulation* is met with only in the head; of which all the bones, excepting the inferior maxillary, are immoveable with respect to each other.

The articulating parts present many differences, both as regards their form and connections; but they are all

united by an intermediate cartilage, which adheres very intimately to them, and by the periosteum which covers this latter in passing from one bone to another. This mode of union is very solid; it is often obliterated in old age by the immediate continuity of two bones, arising from the ossification of the synarthrodial cartilage. This kind of articulation includes several species, namely :—

(a) *The true suture*, that which exists between the bones of the cranium. Here the articulating surfaces present a great many indentations, which correspond to an equal number of proportionate depressions, into which they are received. Some slight differences in the form of the indentations have given rise to the admission of three varieties of this suture; namely, the *tooth-like* (dentata), the *saw-like* (serrata), and the *furrowed* (limbosa).

(b) *The false suture, or harmonia*, is that in which the articulating parts present slight inequalities, which are adapted to each other; as that which exists between the bones of the nose.

(c) *The squamous suture, or articulation.* Here the bones correspond by surfaces, formed as scales, to a variable extent, separating at their edges, which are shelving and unequal; such is the tempero-parietal articulation. This kind of union is termed double, or reciprocal, when the bones do not correspond in their whole extent by the same surfaces. The spheno-frontal articulation is an example of this variety.

(d) *Schindylesis* is that in which a crest is received in a groove, as the articulation of the vomer with the œthmoid and sphenoid bones.

(e) *Gomphysis.* This word expresses the form of arti-

culation of the teeth with the alveolar sockets, when the former are regarded as bones.

2nd. *Amphiarthrosis* is a mixed or moveable articulation, but allied to the synarthrosis, with full and large articulating surfaces, united by an intermediate fibro-cartilaginous plate, which adheres very intimately to them, but sufficiently pliant and elastic to allow of movements to the osseous parts thus articulated.

Such are the bodies of the vertebræ, which move one upon the other, sometimes turning on their axis, sometimes by a flexion forwards.

Fibrous ligaments placed round the amphiarthrodial articulations add still more to their solidity.

These latter, besides their mobility, present, at different periods of life, variations, which arise from those which the intervertebral fibro-cartilages experience. (See Syst. Fibro-Cartil.)

3rd. *The diarthrosis*, or *moveable articulation*, results from the proximity of osseous surfaces, surrounded by cartilage, which are themselves covered by a synovial membrane. This kind of junction is that which unites the bones of the extremities with each other and with the trunk; the occipital bone, and the ribs with the spine, &c.

These surfaces are sometimes plain, more often convex or concave, or sometimes both; but their form is always such that they can adapt themselves to those which correspond to them.

The convex parts, or eminences, are called *heads*, when constituting the entire articulating portion; they have nearly a semi-spherical form: *condyles*, when they are rounded, extended in one direction, and depressed in the

other (as the condyles of the lower jaw). The *heads* and *condyles* are sometimes placed on parts more narrow than themselves, which are called their *necks* (as in the femur and humerus). The depressions are called *cotyloid* and *glenoid* cavities, when they form the whole articulating surface; they are more or less concave: at other times they are named *pullies*, or *trochlea*.

The modes of union of the diarthrodial articulations are by fibrous ligaments placed generally round these joints, sometimes at their centre, and always so as to allow or prevent certain kinds of motion. Solidity is less here than in the preceding species. In general, it is in inverse ratio with their mobility. There are many kinds of diarthroses, which differ from each other by the form of the articulating surfaces, by their modes of union, and by their extent of motion: these are—*(a) the planiform diarthrosis**, composed of surfaces nearly plain, united together by strong and compact ligaments, and susceptible of certain motions, but very obscure (as in the union of short bones, in the articulating apophyses of the vertebræ, &c).

*(b) The arthrodia* has surfaces less plain, less narrowly united, and is susceptible of more extended motion than the preceding (as in the temporo-maxillary).

*(c) The enarthrosis.*—In this, a head is received into a deep cavity, and is there retained by a capsular ligament: the motions are numerous and extensive; these possess opposite characters, as in circumflexion and rotation.

*(d) The rotatory diarthrosis or trochlea, lateral ginglymus.*

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* This is the amphiarthrosis of Meckel and some other anatomists.

—Its surfaces form part of the circumference of a cylindrical osseous piece ; the one is convex the other concave ; the latter is formed almost entirely of ligament. One of the bones performs a rotatory motion, rather confined upon its axis in gliding round the other. It is thus that the radius is articulated with the ulna.

*(e) The angular ginglymus, or hinge-like, or true ginglymus.*—In this articulation the surfaces present eminences and depressions, by means of which they move over each other like pullies : here there is neither circumflexion nor rotation ; the disposition of the projections just mentioned, and of the ligaments, prevents either ; the motions are confined to flexion and extension. Most frequently this latter takes place on the return of the bones to their original position after flexion. In this case, the two lateral ligaments of every articulation of this kind have a particular form to limit extension ; and sometimes an osseous part, suitably placed, still more opposes this latter motion ; an example of which is seen in the olecranon : the articulations of the elbow and knee are ginglymoid diarthroses.

## MORBID ANATOMY.

The diarthrodial articulating surfaces sometimes cease to correspond, in consequence of injuries which have distended or ruptured their ligaments. These displacements are known under the name of *luxations*, to which is added that of *spontaneous*, when the injury arises in consequence of an organic alteration of the ligaments. The articulations are much more liable to these affections in proportion to their mobility, and

also as the articulating surfaces are less extended and less narrowly united.

Besides the accidental articulations which sometimes take place, as we have seen, between the two portions of a fractured bone, there are others which may be termed *supplementary*, and which succeed luxations which have not been reduced; thus an articulating head, escaping from its cavity, and coming in contact with another osseous part, compresses it, and there produces a depression, the surface of which is sometimes lined by a fibro-cartilaginous or even osseous ring, the end of which is covered by a tissue more or less analogous to that of the fibro-cartilages; lastly, there are found in these new articulations, fibrous and capsular ligaments, &c. and synovial membranes. The original cavity then becomes narrow, and takes on the form which would have been given to it by the free developement of all its points of ossification: a form which was modified by the presence of the articulating head. Thus we see the glenoid cavity in the hip-joint, which is formed from three distinct points of ossification, becomes triangular when the femur escapes from it.

The synarthrodial articulations become relaxed in some cases. It is thus that, towards the end of pregnancy, the pubes separate in consequence of the swelling with softening of their intermediate fibro-cartilage. At other times, a more considerable separation is observed in articulating parts. This is what occurs in the bones of the cranium in certain cases of hydrocephalus: external violence may also produce a similar effect.

Bones may be too closely articulated, either in consequence of an acquired rigidity, and even by the ossification of their ligaments; either from adhesions formed be-

tween the contiguous parts of the synovial membrane, or even from this latter and the articulating cartilages having been destroyed by inflammation, or in some other manner; the spongy extremities of the bones then in contact become united together. In this latter case, which constitutes a *true anchylosis*, there is a complete loss of motion in the joint: in the former, as in those of *false anchylosis*, motion is always much less than in the original state, and sometimes is totally lost. Angular ginglymi are more often affected by anchylosis than any others.

Those diseases known by the name of white swellings, depend most frequently on a chronic inflammatory state, which affects, either solely or simultaneously, the hard and soft parts of the articulations.

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Besides the general treatises already noticed:

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*Th. Kerkring*—Osteoginæ Fœtus. Lugdy. Bat. 1717.

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*J. L. Brachet*—Mem. of Phys. Pathol. upon what forms the Fragment of a Bone after Amputation ; in Bullet of the Medic. Society of Paris. 1822.

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*Charmeil*—On the Regeneration of Bones. Metz 1821.

*Reichel*—De Epiphysium ab Ossium Diaphysi Diductione. Lips. 1769.

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*Sandifort*—De Ossibus diverso modo. a solita conformatione abludentibus; in Observ. Anatom. Pathol. lib. iii. and iv. Ludg. Batav. 1777-81.

The following works on Ossification may be read with advantage:

*J. H. Van Heckern* — De Osteogeni. Præternaturali. Lugduni Batav. 1797.

*P. Rayer*—Memoir upon Morbid Ossification; in the Archiv. General of Medicine, vol. i. Paris 1823.

# CHAP. VII.

# ON THE NERVOUS SYSTEM*.

## SECTION I.

### GENERAL CONSIDERATIONS.

*Definition.*—The nervous system is an assemblage of organic apparatuses, connected intimately together, and formed by one of the secondary elements of the animal organization, *the nervous substance;* apparatuses which are composed: 1st. of masses or ganglia, more or less considerable; 2nd. of bundles and cords, some of which establish a communication between the masses themselves; and others extend from these latter to the different parts of the body.

* In addition to the works already noticed at the end of this chapter, the translator of this volume cannot allow the present opportunity to pass, without directing the attention of every medical student to a diligent perusal of the most elaborate and interesting works of *Gall* and *Spurzheim* on the Anatomy of the Brain and Functions of the Nervous System. And, without entering here into any discussion on the science of Phrenology, the writer considers the works of the above-mentioned authors on this subject to be an indispensable study to every well-informed professional man.

*Division.*—From the most ancient time even to our days, the nervous system has been considered as composed of, 1st. a single central portion, which was the spinal cord, according to Praxagoras and Bartholin; the brain, according to Galen, and most of his successors.

2nd. Of prolongations, an expression which included the nerves and all the other parts of the system. Bichât, exhibiting more fully some ideas of Winslow and Reil, established the distinction of two nervous systems; the one, which he named from *animal life*, composed of the spinal marrow, the brain and nerves, which proceed from these masses; the other, which he named from *organic life*, including the ganglia and the nerves, collectively designated by the names of the *great sympathetic* or *trisplanchnic nerve*. With respect to the latter, Bichât maintained, that it constituted not only a separate system, but an assemblage of distinct smaller systems, communicating together, and with the great cerebro-spinal system.

In our days, we have, in adopting the great division established by Bichât, extended his ideas upon the sub-division of the great sympathetic, to the encephalo-spinal system. Also, M. Gall announced, that the encephalon and the spinal cord were an assemblage of ganglia or of independent nervous systems, united together by small filaments, and which could be referred to three classes, namely:

1st. The nervous apparatuses of voluntary motion and of percipient sensations, or those which form the spinal marrow.

2nd. Those apparatuses of the senses included under the name of medulla oblongata; and,

3rd. Those apparatuses of the faculties of the mind, of which

the assemblage constitutes the cerebrum and cerebellum.

A fourth class, composed of ganglia and trisplanchnic nerves, completes the entire nervous system.

The plurality of the nervous systems is generally professed at the present day ; but many anatomists, in adopting this great doctrine, have modified its application ; in this respect particularly, has M. de Blainville, who, relying on a very comprehensive knowledge of comparative anatomy, describes the nervous system as it exists throughout the animal kingdom.

" A number of ganglia, more or less extensive, from each of which arise nerves: some of these terminate in the organ they are destined to supply, and establish its particular life ; while others proceed to communicate with the other ganglia and the central one (when it exists), to establish its general life." This lattter ganglion is found only among the higher animals, and establishes with the greatest certainty the species of the individual. M. de Blainville, adapting these ideas to the nervous system in man, considers it as composed of a central part, the spinal marrow, at the extremities and upon the sides of which are placed the ganglia of the various functions ; at its superior extremity, and on each side of the median line, are found seven ganglia, which compose the encephalic mass, and subservient, some to the intellectual faculties, others to the senses, to the partial motions of the head, and to the digestive and respiratory functions ; on each side of the spinal marrow is found a range of other ganglia, from which arise the spinal nerves ; lastly, in the splanchnic cavities are the ganglia of the nutritive functions, placed near the viscera, which they supply with nerves ; these are, the cardiac ganglion in the thorax, and the semilunar

plexus in the abdomen. The trisplanchnic assumes here the function which it had before Bichât; it is a connecting nerve to all these apparatuses, and is destined to form a general communication: in fact, it is a true sympathetic nerve. We repeat, the plurality of the nervous systems is a doctrine generally admitted in our days; the different advocates of it differing only in the application of this general idea. The manner in which M. de Blainville considers the great apparatus which now engages our attention, is certainly that which accords best with the general law of organization. However, as the ideas of that anatomist are not generally professed, we ought, in a work of this kind, to adopt the division of the nervous system into the *cerebro-spinal*, and *trisplanchnic:* a division, which, while it facilitates the description of this system, allows us also to make known all the opinions on this subject.

*Situation*—The nervous system is spread throughout every part of the body; its central portions are situated internally, its-larger cords more superficially: the divisions of the latter diverge more and more from their central part. However, it will be seen hereafter, that there are some differences as respects the two divisions of this system.

*Form and general disposition*—The nervous system may be regarded as an entire net-work, the filaments of which, interrupted in some places by little swellings (ganglia), and reunited by frequent communications, extend from the circumference of the body to the masses contained in the cavities of the cranium and spinal canal; diminishing in number during this course, acquiring in general a greater increase of volume, and a disposition more and more symmetrical in the two lateral halves of the body: a disposition

more perfect in these latter portions than in any other part of the system.

*Texture.*—The nervous system is far from possessing the same organization in all its parts; however the latter have in this respect common characters. All are formed by a peculiar substance named *nervous fibre,* regarded by M. de Blainville as a secondary element, which results from a great modification of the generative or cellular system.

The nervous substance presents itself under two principal characters, which have given rise to its division into a *white* substance and into a *grey.* It will presently be seen that this distinction does not altogether consist in the difference of colour indicated by these terms.

(*a*) *The white substance* is most frequently found internally; that is, surrounded by the grey; but it is not so throughout, which would seem to be thus meant by the name of *medullary,* which serves equally to denote it: it forms a continuous whole. When its consistence has been increased, by macerating it for some days in alcohol or in diluted nitric or muriatic acid, &c. its appearance then shews it to possess a very distinct fibrous structure, apparent in some parts without any preparation (especially in the nerves). The fibres are placed in parallel or oblique bundles with respect to each other; from which may be separated capillary fibrillæ; but mechanical division cannot be carried further, nor can it be ascertained whether these filaments, which adhere very closely together, are themselves composed of others still finer. The white substance receives many blood-vessels, but less than the grey.

(*b*) *The grey substance* is most often external to the preceding; for which reason it has been termed *cortical,* a name

which does not apply to it throughout, as will be noticed in the next section. It does not form, like the white, a continued whole; but it is always found in distinct portions. This substance exists at the central extremities, or points of origin of the nerves; it is proportionally more abundant, as these latter are larger or more numerous, as may be seen at the summit of the brachial plexus. It is also met with wherever the white is more developed. Whence it has been concluded, that the grey substance produced the other, and was the origin of the nerves. It is necessary to establish the truth of this opinion, to prove, that the appearance of the former always preceded the latter, which is not really the case. The fibrous texture is difficult to distinguish in the grey substance, even with the aid of fresh preparations. It is not admitted by all anatomists; but it is impossible to deny its existence at the present day, at least in the encephalo-spinal mass. This substance is, in general, very vascular, but varies much in this respect in the different parts of the system.

When examined by the microscope, the whole nervous mass appears to be composed of semi-transparent globules, united together by a viscous substance, disposed, according to some observers, sometimes without any order (as in the encephalon), sometimes in lineary series (nerves); always as the last, according to others, and forming thus extremely fine fibrillæ.

Anatomists do not agree as to the size of the globules. Some say that they differ according to the nervous parts, and for this reason place the largest in the encephalon; others affirm that they are every where of the same diameter. This last would correspond to the three hundredth part of an

unit (*millimetre*), according to the recent experiments of M. H. M. Edwards.

As to the nature of the globules, we have only hypotheses: among others, that of the Wenzells, who consider them as vesicles filled with a white or grey substance, according to the parts. However this may be, the globules generally admitted appear to have, as the means of union, an extremely delicate cellular tissue, which unites equally together, and in a very intimate manner, the fibrillæ which are formed from the lineary disposition of the former. This tissue, more compact on the external surface of the nervous organs than in their internal parts, there forms a membranous layer, which receives different names, and varies, as we shall notice in the following sections. This layer is extremely vascular; the vessels which are spread over it penetrate into the nervous substance, and are more abundant in the grey than in the white substance.

The nervous system is among the number of those which do not appear to receive lymphatic vessels.

*Physical and chemical characters and properties.*—The nervous organs are very good conductors of electricity. The two substances do not present throughout the same shades in their particular colours: the grey varies so much, especially in this respect, that it has been remarked of a yellow, of an ash, and a black colour; but these varieties depend simply on the degree of vascularity. The consistence of the white substance is not the same in all parts of the nervous system; but, in this point, it always surpasses the grey. Both, but especially the white, are slightly elastic, retractile, more resisting in one part than in the other, and in that where the fibres are observed; which confirms their existence.

Water very slowly macerates the nervous parts: its first effect is to soften and discolour a little the grey substance.

We have already noticed the effect of diluted acids and spirits of wine upon each of these substances. Solutions of the bi-choride of mercury harden them still more than the other liquids. Desiccation renders the grey substance brittle and easy to pulverise: it is not thus with the white. M. Vauquelin has found the nervous substance to be composed of the following principles: water, 80,00; a white fatty matter, 4,53; a reddish fatty matter (named cerebrine by M. Chevreul), 0,70; albumen, 7,00; osmarone, 1,12; phosphorus, 1,50; acids, salts, and sulphur, 5,15. The nerves contain less fatty matter than the brain: the spinal marrow contains the greatest portion of it. The quantity of albumen is in an inverse ratio to that of this matter. Phosphorus appears to exist only in the white substance. Lastly, M. Chevreul said he had discovered cerebrine in the blood. This analysis does not affect the grey substance of the ganglia of the great sympathetic.

*Order of developement and varieties from age.*—We know nothing certain of the nervous system, either as respects its first appearance or its future growth. It appears only that it developes itself, if not the first, at least as early as the others. Its different parts are not formed simultaneously, but in a successive manner*. Authors are not agreed as to the order of that succession: however, it is sufficiently certain that the nerves and their ganglia appear first; then

* This succession in the developement of the nervous organs is not what the ancients thought the result of a vegetative extension from the part first formed in this system.

the spinal marrow; and, lastly, the different parts of the encephalon. This general order, and that which we shall have occasion to refer to, in each part of the central masses, is analogous to that in which the nervous system becomes progressively more complicated in the animal gradation, in ascending from the lowest to the higher classes. This fact is the principal anatomical proof of the plurality of the nervous systems. M. Gall maintained that the grey substance is formed previous to the white. According to M. Serres, this can be true only in the encephalon: according to Tiedemann and other anatomists, it is the white substance which always appears first: and this opinion seems most probable*. However this may be, the nervous substance passes through all the intermediate degrees of liquid and solid. It is very soft in infancy, and acquires gradually more consistence.

The increase of the nervous organs takes place by interstitial nutrition, and by the deposition of secreted layers on their surfaces, at least in appearance, and by the cellulo-vascular membrane with which they are invested. This increase, extremely rapid in the fœtus, becomes gradually slower towards birth: its growth declines, and it becomes simply an interstitial nutrition, which insensibly diminishes; so that, in old age, the organs are found to have lost that volume which they had acquired at the adult period.

*Vital properties and functions.*—The nervous system is essentially sensible, but in degrees, and according to cir-

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* What may lead to error in this respect is, that, in the fœtus, the white substance presents a slight tinge, which arises from its being at that time more penetrated by fluids than at any other period.

cumstances, which vary as much as the different parts which compose it: it is to its presence in the other organic systems that the phenomena of sensibility, therein observed, are to be attributed. This latter is only a modified property, which belongs alone to the nervous system, and receives the name of nervous power, energy, or influence: a property in virtue of which the whole economy is animated, and the most important functions are fulfilled, as we constantly see. It has, at all periods, been attempted to discover the essence of this property: we shall enumerate the principal hypotheses put forth on this subject, after we have made known, in a general manner, the effects which result from its influence.

The nervous system is the apparatus of *sensation:* a compound function, at least as to its results, by which this system animates all our organs, presides also over all our vital actions, voluntary or involuntary, transmits and perceives the sensorial and affective impressions, and is the medium of the operations of the mind. Each part of the nervous system has its determinate function. Among the lower animals, the smaller apparatuses which compose this system are independent one of the other, and their actions are less rigourously determined; but, in ascending to the higher orders, we behold their functions increase in proportion to the successive additions to this system; at the same time, these functions, far from remaining distinct, become less and less independent, and more subject to the influence of a central point of action, the integrity of which is necessary to their success and regularity. It is the encephalon, and more particularly the medulla oblongata, which is the seat of this physiological concentralization; and this organ exerts a greater influence over

the other parts of the nervous system than the functions of these latter exercise over the nutrition of the individual.

The grey substance, which has been very accurately demonstrated by Tiedemann, increases the activity of the white, in concentrating a greater quantity of blood towards those points where that influence is most required: thus, this substance is more abundant in the spinal marrow, at the origin of the nerves, and the more so in proportion to their size.

Physiologists are not content in referring sensation and nervous influence to a property peculiar to the nervous system. They have sought to discover the essence of these functions. The hypotheses advanced on this subject may be reduced to two, both of them very ancient. According to the first, that which has had the least number of advocates, the nerves performed their functions of centripetal and centrifugal transmission by excited vibrations; in one sense, by external agents, in the other by the brain, the seat of sensation and volition. Besides that this hypothesis is not founded on any facts, it would be inadmissible by this alone, that the nerves are too soft to act the part of vibrating cords. The second theory has had many followers, and includes among them the greatest philosophers both of ancient and modern times, as Galen, Baglivi, Boerhaave, Haller, &c.

It consists in the admission of a subtile fluid, secreted by the brain, and to which was given the name of *nervous fluid*, animal spirits: a fluid which, traversing the nerves with the greatest rapidity, from their cerebral to their peripheral extremities, and *vice versâ*, transmitted to the centre the impressions collected by this latter, and carried to the organs the volitions and nervous influence emanating from the brain. They also imagined two fluids, each destined to one of these

motions, and so very subtile, that they could traverse the same nervous cords in contrary directions at the same time. Other physiologists, to explain the difference of the sensations which are conveyed to the brain, and of volitions, &c. which proceed from it, united the two hypotheses, and attributed the former to vibration and the latter to the animal spirits. Lastly, this association was adopted in an inverse sense; and they modified in different ways the hypotheses of the animal spirits.

These theories, once admitted, they attempted to discover the essence of this fluid, and accumulated propositions, the most destitute of proofs, to substantiate their doctrines.

That which deserved and received the greatest credit is that which assimilates the nervous energy to the electric fluid.

In our days, we are content to observe the laws of sensation; and, if we exceed that, it is to conclude, from the remarkable analogy which exists between certain effects of electricity upon the animal organization, whether dead or endowed with life, and some vital phenomena, that it is permitted us to presume the existence of an imponderable agent which may preside over the nervous functions.

# SECTION II.

## OF THE NERVOUS CENTRES.

### ARTICLE FIRST.

#### OF THE CEREBRO-SPINAL CENTRE.

*Definition.*—We shall describe, with the greatest number of modern authors, under the name of the central part of the nervous system, the cerebro-spinal, encephalo-rachidian mass: that mass of nervous substance enclosed in the cavities of the cranium and spinal cord*.

*Division.*—We have to consider two principal parts in the cerebro-spinal mass: these are—1st. (*a*) *the spinal marrow;* (*b*) *the encephalon,* which includes the medulla oblongata, the cerebrum, and cerebellum.

*Situation* (*a*).—The spinal marrow is situated in a canal formed by the series of cervical, dorsal, lumbar, and sacral vertebræ; but in man it extends only from the superior part of this canal as far as the second lumbar vertebra.

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* We should recollect that this mass includes, according to MM. Gall and Blainville, a series of ganglia, the centres of so many small or nervous systems, and having, according to this latter physiologist, one common centre, the spinal cord. These divisions, however varied, do not at all interfere with the ancient title of cerebro-spinal centre: a collective expression, which is applicable to every kind of division of that continuous mass.

(*b*) The encephalon is situated above the spinal marrow, of which it is a continuation, and fills a great cavity, nearly semi-spherical, formed by a corresponding assemblage of bones called the cranium.

*Form and disposition.*—(*a*) The spinal cord or marrow is a large single nervous bundle, of an irregular cylindrical shape, divided into two symmetrical lateral portions, by two fissures which extend over the whole extent of its anterior and posterior surfaces.

Each lateral half comprises two fasciculi; the one anterior, the other posterior; the line of demarcation of which is at the insertion of the dentated ligaments. This organ is larger at its superior than at its inferior part; but it does not decrease in an uniform manner: in fact, it is thicker in those places where the nerves are given off, and that in proportion to the size of these latter, which arise symmetrically from its lateral sides, to the number of thirty pair. Superiorly, the spinal cord enlarges considerably in entering the cranium, where the encephalon commences under the name of *medulla oblongata;* there, it presents three pair of lateral and symmetrical bundles: the first, or anterior, situated on both sides of the median fissure, forms the pyramidal bodies which, after being intermixed, go to form the peduncles and cerebral hemispheres*; the second pair includes the middle bundles, situated externally to the preceding, and which, protected by the olivary processes, go to terminate in the tuberculi quadrigemina; the third pair, or the posterior

* We do not mean here, by the word 'to form,' a true vegetative generation: it is a mode of expressing the order of developement and the connection of the different parts of the encephalon.

bundles, terminate in the restiform bodies, and go to form the cerebellum, and the annular protuberance which surrounds inferiorly the medulla oblongata. All these bundles send off fasciculi, which form a communication with all parts of the encephalon: this latter constitutes in its assemblage a lobular mass, irregularly hemispherical, composed of symmetrical portions, presenting depressions more or less deep, and corresponding eminences, species of cavities, or single and double ventricles—in one word, a very complex structure, the detail of which belongs to descriptive anatomy. The *medulla oblongata* is the only part of the encephalon from which the nerves arise. The encephalo-spinal mass is covered by three kinds of membranes: the most external belongs to the fibrous system, and is termed the *dura mater;* the middle belongs to the serous, and is called the *arachnoid;* the internal is the *pia mater*, a very delicate cellulo-vascular net-work, in immediate contact with the nervous masses, which enters all the sinuosities on the surface of the encephalon, and dips down into the anterior and posterior grooves of the spinal marrow.

We must remember that M. Gall considers the spinal cord and encephalon as a series of ganglia, united together by intermediate fasciculi; and that M. de Blainville professes an opinion very similar, if we except that he regards the spinal marrow as a ganglion, the centre of all the others, and that he diminishes the number of encephalic ganglia in reducing them to seven pair, as we have before seen (p. 167).

*Texture.*—It is only in the cerebro-spinal mass that we find the two species of nervous substance, the white and the grey. In respect to situation and quantity, there is a variety in the different parts of this mass: thus, in the spinal mar-

row, the grey substance is internal, and surrounded by the white, which is disposed as a layer around it: the former is most abundant in the points whence the great nerves arise.

In the encephalon, we find the grey substance forming the external and cortical layer of the hemispheres of the cerebrum and cerebellum; whilst the white, surrounded by it, composes all the interior of these parts. Besides, in the medulla oblongata, the peduncles of the cerebrum and cerebellum, &c. we meet with portions of grey substance, enveloped by white fibres (the origin of the encephalic nerves) and alternate layers of each of these substances, &c. There is, in this variety of dispositions, no other general law, except that of the continuity of the white substance in the whole of the encephalo-spinal mass, and the isolated condition of the different parts of the grey. The fibres of the white substance, of which alone we can well perceive the direction, are much less apparent in the cerebo-spinal mass than in the nerves; they are disposed in a parallel direction with respect to each other in the two bundles of the spinal marrow, which are united together by transverse fibres, and not by the converging, as some have said. It is very nearly the same with those of the medulla oblongata, except that they commence to be more diverging, and that those of the two anterior or pyramidal bundles cross each other upon the median line. The fibres of the peduncles of the cerebrum and cerebellum unfold themselves in radiating to form the hemispheres of those organs; and, if we credit M. Gall, these same fibres, which he names *diverging*, or those *of formation*, after having arrived in the grey substance which forms the cortical layer of these hemispheres, then return towards the median line under the name of *converging fibres*,

or those of *reunion*, to form the corpus callosum and the commissures.

This method of describing it is disputed by Tiedemann, who says that the cerebral commissures and the corpus callosum are formed from the peduncles of the brain. The cortical substance of the cerebrum and cerebellum abound so plentifully in blood vessels, that, when it is well injected, one might almost believe it was entirely composed of them. To determine the vascularity of either substance, it is only necessary to rupture one or both; the divided parts will then be seen covered with little red points, more or less deep, and much more numerous in the grey than in the white substance: these are the extremities of the small vessels which have been ruptured.

*Physical and chemical characters and properties.*—We shall only mention, in addition to what we have said on this subject, on its general characters, that the consistence of the encephalo-spinal mass is very inferior to that of the nerves.

*Order of developement and varieties from age.*—The spinal marrow is developed before the encephalon; and, among the parts of this latter, the medulla oblongata is first observed, which is only the superior portion of the spinal cord, and to the fasciculi of which are successively added the cerebellum, the tubercula quadrigemina, and the cerebrum.

The cerebrum and cerebellum are much greater relatively to the spinal marrow, as the individual is advanced in life. The tubercular bodies are also larger in proportion to the brain, as the fœtus is younger: these latter are bigemini before they become quadrigemina. The lobes of the cerebellum are at first equal to the middle lobe (vermiform pro-

cess), but afterwards become much superior in respect to size. The cerebral hemispheres are relatively greater compared to the rest of the encephalon, and are much prolonged behind, as the developement of the nervous system is more perfect. All that we have just said will equally apply to the aggregate of vertebrated animals as to the human fœtus.

The encephalo-spinal mass is at first of a semi-fluid consistence, which, a little later, assumes the characters of the white nervous substance, to which is afterwards added the grey substance secreted by the pia mater: this latter surrounds from the first these organs. In old age, the spinal marrow and the encephalon very sensibly diminish in size, and become firmer.

*Vital properties and functions.*—The encephalon and the spinal cord are susceptible of the highest degree of nervous power or energy. Some authors have denied that the brain or any of its parts possessed sensibility. They could not have committed this error, if, instead of considering this property in an absolute manner, and regarding those organs only as sensible on which the action of external stimulants produced pain, they had observed in it, a mode of manifestation of the nervous energy, which, if it could not be excited in some parts of the system, by the fore-mentioned agents, might have been so in all by internal causes, whether physiological or pathological.

We have seen that modern anatomists, in admitting the plurality of the nervous systems, agree to acknowledge a greater or less number of distinct masses or ganglia in the cerebro-spinal centre; and accord to each of these latter a determinate function, which it exercises by virtue of its nervous energy, and which is submitted to the influence of one

common centre. The spinal marrow, among those who differ from M. de Blainville, is regarded as the central portion, and considered the seat of general sensibility (Magendie). The posterior portion of the spinal marrow, some portions of the medulla oblongata, and, according to some authors, the cerebellum, would appear destined especially to external sensations. The anterior portion of the spinal cord, those parts of the medulla oblongata from which the nerves of motion belonging to the face take their origin, and, according to M. Magendie, the cerebellum, and some parts of the base of the cerebrum, preside over voluntary motion. Lastly, this last organ is the seat of internal sensations, the affective and intellectual faculties. The spinal marrow is probably merely an organ of transmission: perceptions and will belong to the encephalon.

That portion of the medulla oblongata, from which the peduncles of the cerebrum and cerebellum arise, seems to be the physiological centre of the encephalo-spinal mass (and consequently of the entire system). To conclude—physiologists describe in very different ways the parts of this mass which correspond to any particular sensorial function.

### MORBID ANATOMY.

From some observations, we are led to believe that the brain is susceptible of experiencing a diminution in volume as old age advances; but it does not appear that hypertrophy of the brain has been ever remarked*. Tumours, situated

* Dr. Elliotson relates a case in the London Medical and Surgical Journal.

in the neighbourhood of the cerebro-spinal masses, may, by compressing these parts, alter their conformation. Curvatures of the vertebral column impress on the spinal marrow changes of form, which seldom influence, to any extent, the functions of this organ. Solutions of continuity of the brain and spinal marrow, when they do not occasion death, heal, like other organs, either by the first intention, or by the formation of a matter very analogous to the nervous substance, and which is deposited upon the points where a loss of substance, or a simple separation of the edges of the wound, leave the part exposed. When, as in apoplexy, and in certain cerebral affections, either blood or serosity is effused into the nervous tissue by rupturing it and getting between its fibres, there is formed, should the patient survive such an accident, a cyst around the effused fluid. This latter is gradually absorbed* : the sides of the cyst approximate, adhesions are formed, and its cavity ultimately disappears. The part of the brain which surrounds these cysts is more or less altered: its colour is yellowish, sometimes of a reddish tinge. These organs are very subject to sanguineous congestions; which is easily accounted for, by the great quantity of blood they receive, and by the facility with which their activity is increased.

Inflammation is not uncommon, and is generally accompanied with that of its membranes. This morbid condition is discovered, in the encephalon and spinal marrow, by the redness, with softness of their substance. Sometimes sup-

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* In this case, the blood separates into the crassamentum and serum, and thus becomes a foreign body.

puration, ulceration, and even gangrene, are its consequences. This latter changes the nervous tissue to the state of a greyish pulp.

The sub-acute form of inflammation of the central nervous masses may also give rise to a purulent secretion, the product of which is sometimes collected in one particular spot in the substance even of the organ, and forms a cyst, in which it afterwards remains for a greater or less period. At other times, the secreted product is only serosity, which is effused either into the encephalic ventricles, into the nervous substance itself, or between this organ and its membranous envelopes. It is this which constitutes *acute hydrocephalus:* a complaint which differs from the chronic by the latter being more generally congenital, and in not being accompanied by any inflammation. This affection is named *hydro-rachis* when it attacks the spinal marrow and its coverings: spina-bifida is also a remarkable variety of the same.

Tuberculous, scirrhous, and carcinomatous developements, fungous productions, fibrous, fibro-cartilaginous, and osseous transformations, are sometimes met with in the cerebro-spinal centre, in consequence of chronic inflammations.

Hydatids are found, in some subjects, in the ventricles of the brain, and even in the substance of the encephalon and spinal marrow. These organs are liable to suffer a considerable softening (ramollisement), attended sometimes with a very variable alteration in their colour. In many cases, this change is evidently the result of chronic inflammation. Induration of the same parts is another disease which exists sometimes alone, at other times with the preceding. Indurated nervous substance is sometimes perfectly homogeneous,

and, in appearance, inorganic, similar to hardened albumen; at other times, its fibrous structure becomes more evident. This alteration appears to be confined more particularly to the white substance. Induration and softening of the brain are met with among idiots, epileptic patients, &c.

The encephalon and spinal marrow frequently present irregularities of conformation. The total absence of these organs, especially of the first (acephalous), or of some of these parts, is not rare. The existence generally in these cases of the remainder of the nervous system proves that all the parts of this latter are independent, as respects their developement, and do not arise one from the other.

The spinal marrow, at the first period of the fœtal state, presents a longitudinal groove on its posterior surface, and, later, a central canal. Sometimes both these dispositions are seen at birth; at other times, this organ is entirely wanting, and instead is found the pia mater, forming a canal filled with a fluid, and giving insertion, as usual, to the roots of the spinal nerves.

Among the more rare defects of symmetry or proportion between various parts of the central nervous masses, we may mention the differences observed between the size of the cerebral lobes.

## SECOND ARTICLE.

### OF THE NERVOUS GANGLIA.

*Definition.*—The name of ganglia is given to those small nervous masses, more or less irregularly round, placed along the course of the nerves*.

*Division.*—Ganglia are divided into two kinds: the first comprises those which belong to the cerebro-spinal nerves, and the second those which are found upon the course of the trisplanchnic nerve. These latter may be again subdivided into those which form a double series upon the sides of the vertebral column, and into those which approach nearer to the median line.

*Situation.*—The nervous ganglia are found exclusively in the head, at the neck, and in the thoracic and abdominal cavities: they do not exist at all in the extremities. Those of the first kind are found near the central extremity, or at the origin of some of the encephalic nerves, and of all the spinal: they are connected only to the posterior root of these latter. Among the ganglia of the second kind, or of the trisplanchnic nerve, some are lateral, placed in double

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* We have seen that MM. Gall and Blainville have also applied the term of ganglion to the divisions of the cerebro-spinal and nervous masses. This generalization, quite a natural consequence of their mode of explaining the nervous system, gives to that expression an exclusively physiological meaning. But that term cannot be appropriate when the question is considered under a less exalted view,—under that of its structure.

series upon the sides of the anterior part of the vertebral column, and designated by the names of the cervical, thoracic, lumbar, and sacral ganglia; to which must be added the little coccygean ganglion, which, although single and on the median line, belongs to this series. Others are less remote from the median line; such are the semi-lunar and cardiac ganglia.

*Form and size.*—The spinal ganglia are all of an oval form: among the others, some are oblong, others irregularly globular: in a word, of very different forms. Their size varies from that of a small bean to that of an almond.

*Structure.*—The tissue of the ganglia appears at first to be homogeneous when divided; but, after they have been macerated, we find that two substances enter into their composition: the one, white or medullary, disposed in filaments, as in the nerves; the other of a reddish grey, pulpy, different from the grey substance of the encephalo-spinal mass, deposited in a kind of cellulosity, which is very adherent to the medullary filaments, of a greater consistence in the trisplanchnic than in the spinal ganglia.

The medullary filaments are evidently the continuation of those which constitute the nerves upon the course of which the ganglia are found. In entering these latter, the cords are deprived of their nervous coat, and divide into filaments, which, imbedded in the grey substance to which they are intimately united (especially in the ganglia of the trisplanchnic), separate from each other to reunite and afterwards anastomose, so as to present a very complex form in the ganglia of the second kind, but simple enough in those of the first. The medullary filaments, reunited into cords, proceed from these last ganglia by the opposite extremity to

that through which they entered; whilst, in the trisplanchnic ganglia, the points of entrance and exit of these filaments are, as respects their situation, very varied.

These ganglia are enveloped by a membrane which is more or less dense: that of the spinal has the thickness of the fibrous tissue; whilst that of the other ganglia is only a membranous layer of cellular tissue.

The vessels of the ganglia are very numerous: the greatest number do not enter these small bodies until they have ramified over their envelopes*.

*Physical and chemical characters and properties.*—The ganglia are of a reddish grey colour, which is more distinct among those of the trisplanchnic. These latter are also much firmer than the others. By boiling, and the action of acids, the ganglia first harden and afterwards soften: alkalies dissolve them slowly. A prolonged maceration in water converts them, according to M. Lobstein, into a fatty substance. They greatly resist putrefaction. Their red substance is not fatty, as some, with Scarpa, have maintained. MM. Wutzer and Lassaigne have discovered, in their chemical researches upon the composition of the ganglia, that these latter contain less of the fatty matter than the nerves, and also than the brain; but, on the contrary, they possess more albumen and gelatine.

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* In comparing these particulars upon the structure of the ganglia with what we shall soon say of the plexuses, we shall see whether or not the characters peculiar to each justify the opinion held by Scarpa, and some other authors, who consider the words ganglia and plexuses as synonymous. The texture of the former is evidently more complicated than that of the latter, and their functions do not appear to authorise any longer this approximation.

*Developement and varieties from age.*—The spinal ganglia appear before any of the others, and even before the rest of the nervous system, excepting the nerves which belong to them. We cannot perceive the trisplanchnic before the third month. They possess, from the first, very nearly the same consistence as in after life, except in advanced age, when they are smaller, harder, and less coloured than in the adult.

*Vital properties and functions.*—The nervous influence is communicated to the ganglia as to the other portions of this system. It appears to be more energetic in the spinal ganglia than in those of the second kind, if we may judge of that, by the sharp painful sensation which accompanies their mechanical or chemical irritation: a sensation these latter do do not perceive, except when they are excited by some internal cause.

Neither of these two species of ganglia manifest vital contractions.

Physiologists are not at all agreed on the office which these ganglia fulfil; and the greatest obscurity still prevails on the history of the functions of these little bodies. Some authors, as Meckel and Scarpa, have considered the ganglia as organs destined to collect and distribute the nerves, or nervous filaments. Others, as Vicussens, Winslow, Reil, Bichât, &c. have regarded them as centres, as focuses of the nervous power, presiding over the sensorial functions independent of the will; that is, of the actions of vegetative life.

This latter opinion, which refers only to the ganglia of the trisplanchnic, is the one most generally received. It is also supposed that they prevent, to a certain extent, the transmission of the impressions received by the nerves which

traverse them; that they concentrate, to regulate the distribution of the nervous energy derived from the spinal marrow; and that they thus render the trisplanchnic nervous system independent of the cerebro-spinal masses. But we must not, as these authors have done, magnify this independence, which is only relative. We know nothing of the functions of the spinal and encephalic ganglia. M. de Blainville considers them as the centre of the nerves to which they belong.

*Alterations.*—This part of the history of ganglia is still very obscure. Several authors, and, among others, M. Lobstein, have observed inflammation of these organs in several diseases; as in tetanus, hooping-cough, and in some abdominal nervous affections. Bichât once found the semilunar ganglia thickened, and, at another time, larger than usual. This latter anomaly was accompanied by the presence of a cartilaginous kernel in the centre of the small organ. The subject in whom this occurred died from a periodic mania. There have also been noticed cases of hypertrophy and atrophy of the trisplanchnic ganglia. It is very probable that the greatest number of abdominal nervous affections depend on some change of these particular organs.

## SECTION III.

## OF THE NERVES.

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### ARTICLE FIRST.

#### OF THE CEREBRO-SPINAL NERVES.

*Definition.*—The cerebro-spinal nerves are white cords, which, from a central extremity united to the substance of the encephalon, or of the spinal marrow, proceed, after successive ramifications, to terminate in certain organs more or less remote from the periphery of the body.

*Division.*—These nerves may be divided, according to the seat of their central extremity, into the encephalic, and into the rachidien or spinal; according to the manner in which they are detaced from that point, into nerves with a single or double origin; lastly, according to their functions, into nerves of sensation, of motion, and those of a mixed nature. Each of these last divisions is also subdivided before they arrive at their ultimate destination; but which we cannot notice here without encroaching on the subject of this article.

*Situation.*—The central extremity of these nerves is situated in the cavities of the cranium and spine; these organs diverge from the periphery of the body in proportion as they ramify.

*Conformation.*—The assemblage of the cerebro-spinal nerves presents, in consequence of their numerous anastomoses, the form of a great net-work, much more symmetrical in its two lateral halves as it diverges from the nervous centres. Their particular form is generally cylindrical; several, however, among them are flattened and striped. Their surface, when examined by a lens, presents little folds nearly transverse or spiral, which are connected only with the neurilema.

*Central extremity (improperly termed origin).*—All the encephalo-spinal nerves are connected by their central extremity to the spinal marrow, or medulla oblongata; not any, strictly speaking, take their origin from the cerebrum or cerebellum. They may be traced, in the substance of the spinal marrow and encephalic mass, beyond the point where they separate from each other; they are always found imbedded in the grey substance. The nerves do not intersect each other at their *origin*, as some have imagined, to explain the causes of paralysis and of partial convulsions, in the lateral half of the body opposite to that where the lesion of the nervous centres takes place, of which these pathological phenomena are the consequence*.

We name the origin of the nerves their central extremity; and, according as this latter is simple or bifurcated, we say that the nerves have one or two origins.

All the encephalic nerves, except the trigemini, belong to the first class; in the second are found this latter, and

* The optic nerves alone decussate each other, but only in a partial manner, and after their separation from the encephalon. Among fish, this decussation is complete.

all the spinal, including the sub-occipital. Nerves which have two origins are connected, by one to the anterior bundles, and by the other to the posterior bundles, of the spinal marrow. It is to the posterior origins alone that the spinal ganglia belong: organs to which the anterior origins are simply united.

*Course.*—The nerves, in diverging from their central extremity, divide successively into branches, twigs, and filaments, by a simple separation of their fasciculi and cords, the assemblage of which forms their trunk. In their course, the nerves unite, either together or with surrounding nerves, by simple anastomoses, or by a kind of interweaving termed *plexus*. The anastomoses are formed by the union of two nerves, which unite very closely by a continuity of substance, and proceed afterwards together as a single one. The plexuses are anastomotic unions multiplied on a single point, not only between two nerves, but between several: unions which are so formed, that the nerves, more or less numerous, which arise from the plexuses, proceed directly from all those which have assisted to form this latter. The cervical, lumbar, sacral, and sciatic plexuses, are the principal of the cerebro-spinal nervous system. The nerves generally preserve the same size until they begin to divide. The total of their divisions presents a volume superior to that of the trunk from which they proceed.

*Peripheral extremity, or termination.*—The cerebro-spinal nerves terminate, after more or less numerous ramifications, in the integuments, in the organs of special sensations, which all depend on these latter; in the external muscles, in the arteries of parts under the influence of the will, &c. At their destinations, the nervous filaments part with their

tunic or neurilema, and sensibly swell. This is all which is known for certain on this subject. Among those anatomists who have endeavoured more deeply to investigate this subject, some have supposed, but have never seen, a kind of fusion of the nerve in the substance of the organ. Others have said, that the nervous filaments, when at their last extremity, fold back on themselves, in forming a kind of duplicature, and return to the branch from whence they arose.

*Structure.*—The first inspection of the composition of a nerve shows a certain number of cords, divisible into filaments of a very great tenuity. These latter are composed —1st, of a white nervous substance, disposed in parallel fibres* ; 2nd, of a sheath or membranous covering, named *neurilema.* The filaments which compose a cord, have, besides their particular envelope, a common neurilema. All the nervous cords are also included in a general neurilema.

The cords are not only placed in juxta-position with respect to each other; they send off filaments of commu-

* MM. Prévost and Dumas have found the nerves, when deprived of their neurilema, composed of a great number of parallel filaments of equal thickness, flat, apparently continuous in the whole extent of the nerve. Each filament is composed of four elementary fibres; two external, very distinct, and two central, imperfectly seen. These fibres are composed of a series of globules, like those of the whole nervous system.

Bogros has endeavoured to shew, by the aid of injections, which do honour to his skill, that the nervous pulp of the filaments was hollowed in its centre by a canal.

The experiments of this anatomist have been repeated by others, who have not always obtained the same results. We cannot, therefore, yet decide whether the canal mentioned by Bogros really exists previous to these injections; or whether these canals are caused by these latter.

nication, and present between themselves plexiform unions: the same disposition is likewise found between the filaments, which, by their assemblage, constitute the cord ; so that neither of them preserve the same situation in the whole extent of the nerve.

Towards the central extremity of the nerves, the neurilema forsakes at first the filaments, then the cords, and surrounds the nerve entirely, only where it is continuous with the pia mater. The result of which is, when a nerve is drawn from the central mass, the internal parts of the latter yielding before those which still possess the general neurilema, there remains upon the marrow a portion of the former, forming a jet, which was considered to be the nidus of the nerve. We have seen that the neurilema completely forsakes the nerve at its peripheral extremity.

The nerves are surrounded by a layer of cellular tissue, which dips down between their cords and filaments, and assists in their mutual adhesion. The neurilema itself is only a condensed cellulo-vascular tissue, which by many anatomists has been classed in the fibrous system. The numerous vessels of the nerves penetrate as far as the neurilema of the nervous filaments. Lymphatics have not been traced in these organs.

*Physical and chemical characters and properties.*—The cerebro-spinal nerves are of a whitish colour, of a slightly rosy tinge. They tolerably resist laceration in consequence of their neurilema, and possess only a very moderate elasticity. Diluted acids, and among others the nitric acid, dissolve the neurilema, and expose the pulpy mass, whilst alkaline solutions destroy this latter and leave the neurilema complete.

It was from a knowledge of these modes of action, both of acids and alkalies upon the nerves, that afforded Reil the means of analysing and showing the anatomical elements which compose their structure. The medullary substance of the nerves yields more albumen and less fatty matter than the cerebro-spinal masses.

*Development.*—The cerebro-spinal nerves are the first apparent parts of the nervous system in the embryo.

In the fœtus, they are proportionally more vascular than at a later period; but their structure is not then very distinct. The neurilematic part appears to exceed the medullary, which appears then merely a kind of fluid. Their size is much larger relatively to that of the cephalo-spinal centre, than when examined at a later period of conception. In advanced age, the nerves are drier, firmer, less fatty than in the adult. Their vitality is at that time less energetic.

*Vital properties and functions.*—The nervous energy manifests itself in these organs by the sharp pains and muscular contractions occasioned by their morbid or artificial excitement. This power is inherent in them, and is not alone dependent on the influence of the spinal marrow and brain; for when a nerve of motion is irritated and separated from these centres by section or ligature, the muscles which they supply are attacked by convulsive movements. No vital contractility has been discovered in the nerves.

The nerves transmit to the centre of perception the impressions which they receive from the organs to which they are distributed, and convey through these same organs the nervous influence, which in some of these latter, as in the muscles, determine their contractions. They are thus conductors of sensation and motion, by a double action from

the centre to the circumference, and vice versâ; during which, neither vibrations nor those oscillations admitted by some authors, to account for the mechanism of these functions of transmissions, are observed. The rapidity with which these latter perform their functions, has given rise to the opinion of an imponderable fluid, an agent similar to that which produces electrical phenomena, and which performs here the principal function ; the nerves being merely the conductors of it.

Many physiological experiments favour this hypothesis. However this may be, it is necessary to distinguish, among the encephalo-spinal nerves, those which are exclusively engaged in the transmission of mobilitity, *or nerves of motion;* those which belong solely to the functions of the external senses, or *nerves of sensation,* and those which are at the same time conductors of motion and sensation, or *mixed nerves.* The two first classes embrace the encephalic nerves, with the exception of the fifth pair ; and the latter includes this last and all the spinal nerves. Nevertheless, M. Magendie has clearly demonstrated, that, even in these latter, the two orders of functions possessed, to a certain extent, their distinct seat ; that the anterior origin was confined to motion, and the posterior to sensation*.

* Mr. Charles Bell has lately made a great many experiments to determine the functions of the nerves, and has obtained very important physiological results. He divides the nerves into the *regular* and *irregular.* The first, common to all animals from worms up to man, preside over general sensibility and voluntary motion ; these are the spinal (including the sub-occipital) and the trifacial, or the fifth cephalic pair, in other words, nerves of double origin. The second, superadded too the preceding in consequence of their function being more complex, go

### MORBID ANATOMY.

The nerves are sometimes found increased in size, in consequence of serous, gelatinous, or fatty infiltrations of their tissue. Tumours which are developed in their course, may compress, flatten, or displace them.

Their atrophy, which sometimes depends upon the same cause, may also arise from a cessation of their functions (as paralysis). When a nerve is divided, the two ends, when only separated by a small space, unite by a nervous cicatrix, and the functions of the nerve, at first impeded between the solution of continuity and peripheral extremity of this latter, are ultimately re-established. The way in which nature accomplishes this reunion is as follows: the superior point, in consequence of an influx of blood, becomes the seat of an exhalation of organized matter, commences to swell shortly

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to organs already amply provided from these latter, and there preside over special functions; these are the nerves of single origin. This physiologist, having divided the branches of the facial nerve in an ass (the portio dura of the seventh pair of Willis) which supply the nostrils, paralysed the muscles of these parts, but only the respiratory motions and expression of the face; on the contrary, when the superior maxillary of the trigemini (fifth pair) was divided, the skin of the face was deprived of its sensibility, and the subjacent muscles lost their contractility; as if it were not alone to assist respiration and expression, that the entire function of this nerve is subservient. Mr. Bell concludes, from these facts, with many similar, that the presence of several nerves of different origins in one part has for its object, not to accumulate in this part more nervous energy, but to render it subservient to several functions. It can easily be imagined how the labours to which we have referred are inclined to the doctrine of a plurality of nervous systems.

after the division, and soon forms a kind of greyish, elongated, and hard nodosity; the inferior point presents in its turn the same phenomena as the preceding; approximated by their tumefaction, these ends unite through the medium of the plastic substance which they secrete. The increase in size which results from the union of the two extremities, remains for some time, then gradually diminishing, at last disappears. The cure is not completed before six or eight weeks. During this process, there appears to be a regeneration of the medullary part of the nerve; and several anatomists state, that they have traced the filaments of the latter into the interior of the wound. What further proves this fact is, that the latter possesses the conductibility of these organs; and that, submitted to the action of nitric acid, far from being destroyed, it acquires more consistence, as happens, in similar cases, to the nervous substance. The restoration of the functions of a part of the nerve, separated from the centre, does not occur when, the separation of its extremities being more considerable, reunion takes place only through the medium of a purely cellular substance. On the contrary, if the separation is very trifling, the power of transmission may take place to a certain extent from one part to another of the nerve, from the moment of its division. Inflammation of this latter (neuritis) appears more common than believed; it is sometimes met with among those who have suffered from neuralgic affections, complaints which do not appear to cause any appreciable alteration in the tissue of the nerves. It is also probable that it is a subacute inflammation of these organs which produces their softening (ramollisement), and those occasional tuberculous, and scirrhous tumours, known collectively by the

name of *neuromas.* We shall refer also to a similar cause those cartilaginous and osseous changes in the nerves : a kind of change which is comparatively very rare, and is confined to some isolated parts of these organs.

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## ARTICLE SECOND.

### OF THE GANGLIONIC NERVES.

*Definition.*—The nervous cords, which we are now about to describe, are those which constitute, with the ganglia of the second kind, the system of the great sympathetic or trisplanchnic nerve ; those, in other words, which are situated exclusively in the trunk, form with the fore-named ganglia a particular order of nervous apparatuses, communicating together and with the spinal nerves by intermediate branches, and distributing numerous twigs to the arteries and organs of vegetable life. (Whence the name of nervous system of organic life, given by Bichât to the assemblage of these apparatuses.)

*Division.*—We can distinguish three varieties of ganglionic nerves : the first, comprises those which establish a communication between the ganglia themselves ; the second, those which are intermediate to these latter and to the cerebro-spinal nerves ; and the third, those which supply the various organs.

*Situation.*—The intermediate nerves to the ganglia are for the most part situated upon the sides of the spine, parellel to the axis of this latter, between the double series of lateral

ganglia, which extend from the head to the coccygis; others proceed from these last to the middle ganglia. The branches of the second division are situated most frequently transversely upon the sides of the spine, between each lateral ganglion and the corresponding spinal nerve. The situation of the branches which supply the organs varies in each of them: like the preceding, they belong exclusively to the trunk.

*Conformation.*—The assemblage of the ganglionic nerves does not present the symmetry of those which arise from the cephalo-spinal masses. Béclard has very justly compared their system, including in it the ganglia, also the great sympathetic nerve, to the root of a tree, or to an articulated rhizoma, which at each knot presents on one side roots, and on the other branches, which like each other go off at right angles, or at least nearly so.

With respect to their particular form, the ganglionic nerves do not all resemble each other. Those belonging to the second variety are rounded, and thus resemble the spinal nerves; those of the two other varieties are flattened; and again, those of the third kind possess this particular character, that instead of diminishing in size in proportion as they ramify, they increase or diminish indiscriminately. All are thicker at the margin of the ganglia than in the rest of their extent.

*Origin.*—The question has long been agitated, whether the ganglionic nerves arise from those of the cerebro-spinal system with which we have seen them communicate, or whether the ganglia ought to be regarded as their centres of origin? Neither of these propositions is strictly admissible; for the development of these nerves is independent from that

of the other nervous parts: but in giving, as we have already done, to the word *origin* the meaning of *central extremity*, we ought to place this latter in the ganglia of the great sympathetic, and consider the nerves which depart from these latter to the organs as forming with the former so many small nervous centres, which communicate together and with the cephalo-spinal nerves. At this central extremity the medullary filaments of the ganglion are continuous with those of the nerve, and also the envelop of the former extends over this latter; thus adding to the solidity of their mutual adherence, and, enclosing the second in a little fold, gives it the appearance of a part of the ganglion, elongated in the form of a cord.

*Course.*—The ganglionic nerves of the first variety proceed directly, and without offering any thing particular, to the cerebro-spinal nerves. It is the same also with the cords which establish the communication of the ganglia, and especially of those which, placed on each side of the spine, form, with these latter, what is termed the trunk of the great sympathetic nerve. As to the nerves which go from the ganglia to the arteries, and to the different organs at the superior part of the neck, to those of the chest and of the abdomen, they ramify in their course, and form plexuses more or less complicated, either before they arrive at their destination, as in the cardiac and solar plexuses, or after they have arrived there; this happens to many arteries, upon the sides of which are seen the filaments interwoven, proceeding directly from the ganglia. In their course (and in their plexuses), these nervous filaments unite with branches proceeding from the encephalic nerves, and particularly with those of the pneumo-gastric.

*Organic extremity or termination.*—The ganglionic nerves (and, there can be no doubt, those also of the third variety) terminate in the parietes of the arteries of the trunk, in the the heart, in the digestive apparatus and its appendages, and in the genital and urinary organs.

*Structure.*—The ganglionic nerves of the first variety, and also of the second, are composed of medullary fibrillæ, and of a neurilema, thicker at their extremities, where it is connected with the covering of the ganglia, thinner at their central part, and more intimately united to the fibrillæ than that of the cerebro-spinal nerves.

These latter are, besides, imbedded in the peculiar reddish grey substance which we have already found in the ganglia: they are very difficult to separate from each other.

Notwithstanding the differences which we have just remarked between these nerves and those of the cerebro-spinal system, both have similar appearances in colour and structure. (The fibrillous and nervous structure, which is common to them, is proved under this last point of view.) The branches which unite the ganglia to the spinal nerves resemble particularly these latter, and that in proportion as they are more minutely compared together.

As to the third variety of nerves, we cannot distinguish in them any fibrillæ, and they appear formed solely by a soft reddish pulp, around which it is impossible to demonstrate the existence of a neurilema.

*Physical characters and properties.*—The nervous cords which proceed from the ganglia to the cerebro-spinal nerves are whitish, like the latter, a little less firm and resisting, and appear to be deprived of elasticity. Those which unite the ganglia together are not quite so white as the preceding

(the pulpous matter being rather more abundant in them), and are slightly inferior to them in tenacity and consistence. The ganglionic nerves which supply the organs are, with some exceptions, reddish, very soft, and fragile.

*Vital properties and functions.*—The nervous power of the ganglionic nerves appears to be less active than that of the cerebro-spinal nerves, and that in proportion as they are separated from these latter by more ganglia.

This power does not manifest itself in them in the healthy state, either by sensibility or contractility; but, in certain affections, they are the seat of a peculiar, painful sensation.

The ganglionic nerves transmit the nervous energy to the organs of the involuntary and insensible functions; but they do not conduct to the centre of perception the impressions received by these organs, unless their action is excited by disease, which the ganglia probably arrest in ordinary cases.

They have, if not all, at least those of the two first varieties, some effect in sympathetic phenomena, in establishing communications between the nervous ganglionic and the cerebro-spinal systems; but it is doubtful if they be, as was stated before Bichat, the essential organs of sympathies.

All the nervous parts are, in consequence of their intimate connection, susceptible of this latter influence. The action of the ganglionic nerves, more independent than that of the others of the cephalo-spinal centres, is however subservient to these latter; for it soon ceases when these nerves are separated from the cerebro-spinal. The nervous power or principle, transmitted to the ganglionic nerves by the centres already described, does not reach the organs until it has been, most probably, divided and modified in the ganglia which distribute it to these latter.

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This, then, appears to be the function which is attributed to the ganglia, considered as independent, and which is possessed by that portion of the nervous system to which they belong.

## MORBID ANATOMY.

The pathological condition of the ganglionic nerves has been but little studied: their inflammation has been noticed in some nervous affections of the abdominal organs, and among some subjects who have died from hooping cough.

There has also been observed atrophy and hypertrophy of some of these nerves, when the organs, in which they were found situated, themselves presented these pathological conditions.

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# CHAP. VIII.

# THE TEGUMENTARY SYSTEM.

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## SECTION I.

### GENERAL OBSERVATIONS.

SYNON. Dermoidal system; common integuments; the skin, including all the tissues of which it is composed, as the epidermis, dermis, chorion, &c. &c.

*Definition.*—The tegumentary system is composed of a large membrane which covers the whole surface of the body, and penetrates this latter, to line all the cavities which communicate with the external world.

*Division.*—It is divided into two secondary systems: the cutaneous, or external tegumentary; and the mucous, or internal tegumentary.

*Situation.*—The teguments are placed over the surfaces of the animal, which communicate more or less directly with external objects Thus, after having enveloped the external surface of the whole body, they are continued into the cavities of the same, which open externally, either directly or indirectly, as in the mouth, the œsophagus, the stomach, the intestines, and all the excretory canals which are found there, in the air passages, the nasal fossa and all their sinuses, in the genital and urinary organs.

*General conformation.*—The most general form under which the tegumentary system may be represented is that which

would result from the union of two hollow cylinders, connected by their extremities, and whose contiguous surfaces might be separated by an intermediate matter, representing, by its situation, all the other organs of the body. This comparison is only applicable here to the skin and mucous membrane, which is continued with the latter from the mouth to the anus. It will include the whole of the teguments, if we add to these cylinders species of prolongations or appendages, which penetrate into various parts of the intermediate substance, and there line parts analogous to the air passages, to the excretory ducts of the glands, to the genital and urinary organs, &c.

*Surfaces.*—The tegumentary membrane presents two surfaces; the one free, the other adherent. The former, external for the skin, internal for the mucous membrane, is connected, in a continued or interrupted manner, with substances actually foreign to the organization.

There are seen in it small granular eminences, porous depressions, and horny or calcareous productions, either collected in one point, or situated alone in different parts. We shall return to these bodies when treating of the structure.

The adherent surface, internal for the skin, and external for the mucous membranes, is exactly similar to a layer of cellular tissue, which we have described in the first chapter, and by the intervention of which this surface is connected with the subjacent organs. There is seen upon this latter some eminences more or less distinct, which correspond to the small depressions on the free surface.

*Structure.*—We must consider, in the organization of the tegumentary system, 1st. the different layers of which it is

composed, and give it, by their superposition, the membranous form; 2nd. of the little secretory organs.

The layers which form the tegumentary membrane are five in number; they vary in a very sensible manner, according to the different parts of this organ, and present especially remarkable differences in its two great divisions: we shall enumerate them in describing their most general characters.

1st. *The dermis*, or chorion, the most internal of these layers, is also the thickest, and constitutes the basis of the integuments: it is formed by a cellular tissue more or less compact, which admits between its fibres a very numerous supply of vessels and nerves.

2nd. *The vascular net*, placed above the dermis, is formed from the interweaving of small arterial, venous, and lymphatic vessels, which traverse this latter. This layer is extremely delicate.

3rd. *The papillary body*, the existence of which we cannot demonstrate, appears to be formed by the peripheral extremities of the nerves which cross the preceding layers. It is very probable that those small eminences situated on the surface of the teguments, which are called *nervous papillæ*, belong, like the greatest part of the others, to the dermis itself, and are covered only by the extremities of the nerves, which traverse this latter with the vessels, and terminate on its surface.

These two last layers, strictly speaking, do not exist, but ought rather to be regarded as the superficial portions of the first described.

4th. *The mucous body of Malpighi* is a layer of semi-organized mucus, which contains the pigment or colour-

ing matter of the skin, surrounds the superficial layers of the dermis, and is itself covered by the epidermis. Bichât and M. Chaussier deny the existence of the mucous tissue, first described by Malpighi, and since by several anatomists. On the contrary, some of these latter, and among them M. Gaultier, relying upon observations made on the skins of negroes, have described it as composed even of several layers.

5th. *The epidermis,* or *external skin,* is the most superficial of the tegumentary coverings. It is not distinct in every part of this system. The epidermis is considered by some as formed by the superposition of several layers endowed with a vitality which diminishes progressively from the most internal to the most superficial; by others, as possessing a squamous texture. The epidermis is a whitish, semi-transparent, membranous substance, adapting itself to all the eminences of the dermis, and considered generally in the present day as insensible, and deposed by excretion on the surface of the teguments.

The small secreting organs which are observed in this system are known by the names of *follicles,* of *simple glands,* of *cryptæ,* &c. They consist in species of cysts extremely small, round or oblong, terminated by a more narrow part: a kind of neck, which performs the office of an excretory canal, and which opens on the free surface of the teguments: whence arise those minute porous depressions which are seen on this surface, as we have already noticed.

The follicles would appear to result from a simple depression of the tegumentary membrane; for we find them formed of the same anatomical elements as these latter; that is, of a dense capsule similar to the dermis, surrounded and traversed by numerous vessels; of a vascular nervous net-

work, spread over the concave surface of this latter; of excretory parts, which vary according to the kinds of follicles, and which sometimes enclose a pigment or colouring matter similar to what is seen in the hair, &c. The follicles may be divided, according to the nature of their product, into two kinds; the first comprises those little organs which secrete a matter more or less fluid, and pour it on the surface of the teguments; these are the true follicles so called, or the cryptæ, organs whose product we shall also see varies according as they belong to the skin or mucous membranes. They exist in the whole extent of the teguments; but they are not throughout equally numerous: sometimes they are found isolated, and at other times collected in a greater or less number, and often with regularity*.

The second kind is composed of follicles, designated more particularly by the name of bulbs or radicles, and which M. Blainville names *phancres*, because the parts produced, always solid, remain apparent on the surface of the animal: these are the hairs, the nails, and the teeth.

The bulbs are found only in certain parts of the tegumentary tissue, and are almost always collected in a greater or less number.

*Physical and chemical characters and properties.*—The colour of the tegumentary membrane varies according as it is owing to the presence of blood, or pigment; there exists in this respect remarkable differences, not only between the external and internal teguments (these latter

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* We shall see, in the following chapter, that the glands are merely groups of cryptæ, which differ only from those which we are now describing by the number and arrangement of these latter.

having no pigment), but likewise between the various parts of each of these species. These latter no longer resemble each other as respects their density, or thickness; we may, however, in a general way announce the degree of the former, by describing it as intermediate to that of the density of the cellular and fibrous tissues. The teguments allow of considerable extension; after which they return to their original dimensions, either quickly or slowly, according as the distension is recent or otherwise, and also as the cause of this latter disappears slowly or with rapidity. The elasticity, or rather the retractility, of the tegumentary membrane, is likewise made evident by the ready separation of its edges at the moment when a solution of continuity takes place.

The dermis is almost entirely resolved to gelatine by decoction; this principle, with some mucus, appears to enter into the composition of the reticulated body of Malpighi. The epidermis is insoluble in water. M. Vauquelin considers it as indurated mucus. Hatchett, as coagulated albumen. Putrefaction commences in the subjacent layers of the epidermis: this latter is detached by the liquids which transude from the dermis soon after death.

*Vital properties.*—The teguments possess a very active vitality; the numerous nerves which are distributed to them render them extremely sensible, but in a manner, and to a certain extent, which vary much according to their different parts. Their vital contractility is equally remarkable.

*Differences from age.*—Wolff, Ocken, Meckel, viewing the vitelline membrane of birds as analogous to the umbilical vesicle of mammiferous animals, have maintained that the intestinal canal corresponded to this latter from the commence-

ment of the human embryo, and that the tegumentary membrane of this canal existed before all the other organs. According to this mode of viewing, the internal tegument would be formed before the external. These conclusions are far from being correct; and we know nothing certain at present upon the first periods of the formation of the teguments.

It seems natural to suppose, that these latter do not precede in their developement the organs which they are destined to cover. Thus the skin, which at first forms only half a canal, open at its anterior surface, because, at the same time, the parietes of the trunk present an interruption to the anterior part of this latter—the skin, we say, approaches successively from the median line in proportion as these same parietes also approach, and do not cease to present an interruption until these have united themselves. The teguments pass successively from a semi-fluid consistence to that under which we notice them. Their thickness is in direct relation to the age. The differences which exist between the external and internal layers, very indistinct at first, show themselves as soon as the period of formation advances.

*Functions.*—The tegumentary system covers every part of the body; consequently protects it against the intrusion of bodies foreign to the economy, and keeps up the connections of this latter with the external world: 1st. as the organ of general sensibility, and of special sensations; 2nd. as the organ of absorption and exhalation. The various portions of this system have not the same parts for these functions; differences which result from those which these same parts will present to us in their organization.

The expansion of the tegumentary organ, and the im-

portance of its functions, render its state of integrity of the highest importance for the general health. Besides, the great sympathy which exists between the different parts of this organ requires that the health of one of these parts should correspond to the anatomical and physiological condition of the others, and sometimes more especially of some one between them. Thus, the suppression of the cutaneous exhalation is almost constantly followed by an increased discharge from some mucous membrane; and this increase of activity, or rather the humoral congestion which has taken place in this case towards the latter, may be followed by its inflammation: such is the most frequent cause of bronchitis, pneumonia, &c.

## SECTION II.

### OF THE EXTERNAL TEGUMENT, OR OF THE SKIN.

*Definition.*—The skin is that part of the tegumentary membrane which covers the whole external surface of the body.

*Division.* — We distinguish, in the external teguments, the membrane which essentially forms it, and what are commonly termed its appendages, that is, its productions, which are in man the nails and the hair. We shall consider these parts, with the appendages of the mucous membrane, in the fourth section of this chapter.

*Form.*—The skin presents the form of the body, since it limits its boundaries. It is said to have openings in some places, as in the mouth, the nostrils, the anus, the genital organs, &c.; but these are only apparent, for the places where they are seen are those where the external tegument penetrates the interior of the body, and becomes a mucous membrane, without any interruption of continuity.

The skin presents folds or wrinkles, some of which arise from this membrane not being so capable of contracting as the subjacent tissues, and is puckered to accommodate itself to the retraction of these latter; and sometimes, from having lost with age a portion of its elasticity, it cannot retract when the fat, or the organs which it covers, cease to support it by decreasing in size.

The other folds, or wrinkles, are those which are seen upon

the skin of the articulations, and arise from the intermitting extension which the movements of these latter produce on this membrane.

*Surfaces.*—The external or free surface of the skin is in contact with the external world. It is closely united, especially in women, and moistened by the perspiratory and sebaceous exhalations. There are also observed in it, besides the folds already mentioned, small papillary eminences, and depressions of various kinds. The eminences are either isolated, or disposed in lines in various directions. The most numerous and remarkable for the regularity of their disposition are those in the palms of the hands and soles of the feet. We find upon this same surface the orifices of the sebaceous bursæ; orifices more numerous and apparent in the face, especially on the sides of the nose, than in any other parts.

Lastly, the external surface of the skin presents, in certain parts, the products excreted by the bulbous or *phaneric* follicles; that is, the hair and nails.

The internal or adherent surface is united by a cellular tissue, sometimes loose and sometimes very compact, to the subjacent parts, and that according as the skin conforms itself or not to the folds more or less extended over these parts. We have also seen that the synovial cysts were placed in some parts between these latter and the tegumentary membrane, to assist their motions. This latter rests most frequently upon a layer of adipose tissue; at other times, it is intimately united to the fibrous organs; lastly, it adheres, in some places, to the muscles which receive the name of *cuticular (peauciers):* muscles much more

generally found, and more important among most animals than in man.

The internal surface of the skin presents areolar depressions, obliquely situated, enclosing adipose tissue, and whose ends, pierced by little foramina, give passage to the vessels and nerves. These depressions, almost invisible in some parts, as in the dorsal part of the foot and hand, the scrotum, &c. are of a remarkable size in the palms of the hands and soles of the feet, in the back, abdomen, &c. We see also, on the same surface, little projections formed by the follicles of the skin: secreting organs which, as we have said, seem to result from a depression of the latter.

*Structure.*—It is necessary to return here with fresh details upon the layers which have been considered in the preceding section.

(*a*) *The dermis*, or the principal layer of the cutaneous organ, is formed by a peculiar cellulo-fibrous tissue, which some anatomists have thought was composed of muscular fibre; but this latter would appear to result from a modification of the generative tissue, less characterized than that which constitutes this fibre.

The fibrous structure of this tissue is evident only in the palms of the hands, in the soles of the feet, and in all those places where the dermis is united to a layer of fibrous tissue. It may thus be regarded as the most superficial part of this latter, from which it is hardly possible to separate it.

The fibres are much less distinct over the greatest part of the trunk and the extremities; lastly, they are not seen at all upon the dorsal part of the hand and foot, on the forehead, &c. The dermoid tissue is less compact on its internal than

on its external surface. This latter is covered by the vascular net-work, and presents papillary eminences, which we have already noticed, on the external surface of the skin: eminences much more evident on the dermis, when deprived of its subjacent layers, which tend to efface them.

The internal surfaee rests almost every where upon a layer of adipose tissue, more or less thick, which penetrates as far as the meshes of the dermis, and contains a great number of vessels and nerves.

Those of these two kinds of organs which are destined for the skin penetrate into the areola of the dermis, throw some filaments into its tissue, and terminate, for the most part, on its external surface, where they form, by their interweaving, the second layer of the skin. The dermis is generally white: when its vessels contain much blood, it has a reddish colour. It is very thick at the posterior part of the trunk, on the external surface of the extremities, in the palms of the hands, and in the soles of the feet, on the cranium, &c.; thinner and more united on the anterior part of the trunk, on the internal surface of the extremities, on the face; lastly, very thin on the eyelids, the genital organs, at the nipples, &c. The thickness of the dermis varies in these different parts from about one to three lines (*millemetres*). The dermis is supple, elastic, and retractile: dessiccation gives it the elasticity of horn; deeoction reduces it into gelatine*.

* It is the gelatinous nature of the chorion which renders it proper to answer the various uses in the arts and in society: in fact, gelatine, combined with tannin, forms an insoluble compound, which resists putrefaction, and is obtained by putting the dermis in contact with different barks (those of oak, fir, &c.) which contain the principle now described.

It manifests true vital contractions, under the influence of cold, under that of certain moral affections, &c.

The papillæ which are observed on its external surface favour the tactile sensibility of the skin; at least they are more developed in those places where this sensibility is more exquisite.

(*b*) *The vascular net-work* is only, as we have said, the most external surface of the dermis, and not a distinct layer. However, it is very much developed in certain parts, habitually of a red colour, as in the cheeks, and there suffers a kind of erection produced by certain moral affections. It is this part of the skin which is the true seat of the exhalations and cutaneous absorptions.

(*c*) *The papillary body* is not equally distinct on the superficial part of the dermis: it is this which is said to form those papillæ which the external surface of this latter presents; into which enters also the vascular tissue. The tactile sensibility of the skin being in direct ratio to the number of these little eminences, it is thought that the nervous substance is more abundant there than in any other parts of this membrane; but examination affords us no information on this point.

(*d*) *The mucous body*, which Bichât and M. Chaussier have not been able to discover, notwithstanding the most careful dissections, is spread, according to those who have seen it, under the form of a mucous layer, upon the preceding parts, and moulds itself precisely over the papillæ. This layer is much more distinct as the skin appears of a deeper colour, of which also it is the seat. It is generally regarded as simple; but some persons, and particularly M. Gaultier, say it is formed of several layers. This latter

anatomist, relying on experiments made by him upon the skin of negroes, enumerates four layers in the mucous body: the first, the internal vascular, which secretes the colouring matter of the skin; the second, placed immediately upon this, white, inorganic, and which is named the *deep albugineous;* the third, composed, like the first, of arterial vessels and veins, united in clusters, and impregnated with the colouring matter of the skin; the fourth, or the *superficial albugineous,* is inorganic like the second, secreted by the third, and covered by the epidermis.

M. Dutrochet admits these three last layers; viewing the first as identical with the vascular tissue of the surface of the dermis. However this may be, the colouring matter of the skin, placed by many anatomists in the dermis, and by others in the epidermis, is really intermediate to these two layers, without being, however, completely foreign to them. This matter, named the pigment, is secreted in the mucous body under the form of globules: we can separate this substance by a long maceration, which, by dissolving the semi-organized mucus in which it is imbedded, insulates the latter without altering it.

Experiments of this nature can be made only upon men of colour: the skin of white men contains much less of the pigment. It is to its absence that the state of the skin is owing in albinos.

The thickness and consistence of the mucous layer are in direct relation to the abundance of this matter. This latter is almost entirely composed of carbon. It seems to assist in preserving the external tegument from the rubefacient action of caloric, by absorbing its rays, and preventing them penetrating the papillary body. Thus albinos are

very sensible to the action of the solar rays, which may even occasion blistering of their skin.

(*e*) *The epidermis*, the most superficial covering of the skin: is a very delicate membranous layer, which adjusts itself very perfectly upon the preceding, and adheres very intimately to them, 1st. by the hairs which traverse it, and to which it furnishes a cortical expansion; 2nd. by little filaments, which are perceived between the dermis and epidermis, when putrefaction detaches one from the other, or when that separation is accomplished by plunging the skin into boiling water.

These filaments are hypothetically regarded by some anatomists as exhalent and absorbent vessels. Béclard thinks with reason that they may be considered as mucous traces, formed by the intermediate substance to the dermis and to the epidermis, rendered more fluid by an incipient state of decomposition.

The epidermis covers the whole surface of the skin, as a kind of dry varnish, and penetrates, by becoming thinner, into the sebaceous and phaneric follicles. Its structure has been variously described by anatomists: some, among whom are M. Mozon, De Turin, Mascagni, M. Gaultier, &c. have considered it to possess an organization more or less complicated; others have thought it was formed of scaly layers: but neither of these opinions appears to be well founded. M. de Humboldt, having examined this layer with a very powerful microscope, neither found in it vessels nor the least appearance of organization. The epidermis appears to be only an exhaled substance, concreted on the surface of the mucous body, or rather on the most external part of this latter.

Is the epidermis porous? This is what we might at first believe, when we see drops of perspiration issuing from certain parts of this membrane, depressed so as to give them the appearance of perforations: points which appear, besides, much more transparent than the parts which separate them when a portion of the epidermis is placed between the eye and the light. Leuwenhoeck believed in the reality of these perforations. Bichât thought that they were placed obliquely, and this reason alone prevented their being perceived; but repeated observations, among others those of M. Humboldt, do not at all justify this opinion; for neither inspection nor experiments have been able to detect any pores in the epidermis. This membrane is thinner in the situation of these particular parts than in others.

Besides this difference in thickness, common to the epidermis throughout the body, we find in it others, when this membrane is compared in the different regions of the latter: thus, it is much thicker in the palms of the hands, and particularly in the soles of the feet, than any where besides; and it is not solely to the continued friction which these parts suffer, that we must attribute this difference; for the same already exists, though in a very inferior degree, in the fœtus. In those parts where it is thickest, the epidermis seems to be formed of several layers. It is whitish in white nations, greyish among black; it is semi-transparent, supple, and less elastic than the dermis; and that, in direct relation to the moisture which penetrates it. It is slightly hygrometric; it becomes opaque and thick by maceration in water: changes which rapidly take place when immersed in hot water. It resists, for a long time, putrefaction; boiling does not dis-

solve it. Potash and soda form with it soapy compounds; when nitric acid is applied to it, it becomes yellow, and is reduced to a pulp.

These chemical characters have caused it to be regarded as an albuminous substance.

The epidermis does not possess any vitality, and performs only a mechanical function in the animal economy, in diminishing, by its interposition between external bodies and the dermis, the impression of the former upon the nervous part of this latter.

Notwithstanding its feeble hygrometrical power, the epidermis affords a passage to the product of perspiration, and allows, to a certain extent, foreign substances, either liquid or gaseous, when applied to its surface, to be absorbed into the system.

There also enters into the structure of the skin a great number of sebaceous and bulbous follicles. These will be considered when treating of the solid parts which they produce.

As to the sebaceous follicles, it is not known whether they are spread all over the skin: however, they are found in great numbers on the face, round the sides of the nose, in the groins, under the arm-pits, round the anus, and in the most concealed parts of the body. These are, as we have already observed, very small vesicles which open on the surface of the skin, have no epidermis, and seem to result from simple depressions of this membrane.

They secrete an unctuous matter, which sometimes accumulates and deposits itself in their internal part; from whence it is forced out by pressure under the form of little maggots. This secretion is termed the wax in the auditory apparatus.

It defends the skin from the action of fluids applied to its surface, and, in this respect, fulfils the same office as the epidermis.

*Physical and chemical characters and properties.*—The different modifications of the layers which compose the skin, by their assemblage, form a membrane, the colour of which varies, according to the human race, from white to black, including all the intermediate shades: it is supple, elastic, thicker among the dark than white races, rather difficult of penetration by fluids in contact with its free surface; composed, at least in a great measure, of gelatine, and of a certain quantity of albuminous mucus.

*Vital properties.*—The skin derives an exquisite sensibility from the great number of nerves which are spread over the external surface of the dermis, more distinct in those parts abundantly provided with papillæ; and, all other things coinciding, in those where the epidermis and mucous bodies are less thick than in other parts. The external tegument is susceptible of very sensible vital contractions, which impart to it a very peculiar appearance, known under the name of goose flesh.

*Varieties from age and sex.*—The skin is not distinct until the end of the second month, at which period the epidermis is also found at first colourless and so very fine, that it is perfectly transparent; the skin soon assumes a rosy hue, which it presents also at birth. The sebaceous cryptæ appear about the middle of the fœtal life. At this latter period, the external surface of the skin, in contact with the liquor amnii (waters of the amnion in which the fœtus is suspended), is covered with an unctuous substance. At birth, the external tegument, which at this time appears nearly

of the same colour among all nations, assumes the character of the colour peculiar to these latter. The colour is first seen about the genital organs, round the nipples, the eyes, the nails, and, at the end of the first week, it extends over the skin. This membrane, which is very delicate and closely united in children, acquires with age a greater thickness and consistence. In advanced years, it becomes dry, and loses its retractility. In women, it preserves nearly the original delicacy which it had in infancy.

*Functions.*—The skin is an organ of tactile sensations, or involuntary passive; and of feeling, or voluntary active. this membrane exhales two kinds of fluids, which are given off from its free surface: the one is the sebaceous liquid which we have already noticed; the other is a thinner fluid which is perpetually exhaled under the form of vapour, and sometimes as a liquid (which constitutes the perspiration), and that probably from the points of the epidermis, the thinness of which has led to the belief of its being perforated. The vapoury product, or the insensible perspiration, is very abundant; it is, in the relation to that which supplies the pulmonary mucous, as eleven to seven. This product contains carbonic acid gas and an odorous animal matter. When it becomes so abundant as not to be evaporated on arriving at the surface of the skin, and that it presents itself under the form of small drops, its composition appears to be a little more complex and different*.

* The sensible or insensible perspiration is a very important mode of purification; the suppression of which occasions the worst maladies. This exhalation has also for its object the maintaining the temperature of the body, by dispensing with a superabundant quantity of caloric which

M. Berzelius obtained from its analysis the hydrochlorate of potash and soda, lactic acid, tartrate of soda, and a little animal matter. The perspiration has an odour, suî generis, more or less strong, according to the individuals, and more so in infancy than at any other period. Some observations would lead us to believe, that the subcutaneous fat is exhaled also through the skin, if not constantly, at least when the temperature of the body is much increased.

The skin absorbs, but very slowly and only in small quantity, fluids placed in contact with it; it is therefore erroneous to consider this membrane as a very important organ of absorption.

The little permeability of the epidermis is an obstacle to this function, which is very active when this membrane is removed.

The skin in man can hardly be regarded as an organ of defence; however, it fulfils this office by means of the epidermis and the solid productions on its surface.

## MORBID ANATOMY.

When the skin undergoes a considerable and prolonged distension, as happens in pregnancy, the fibres of the dermis are not only separated and elongated, but a certain number of them are torn; when the membrane returns to its previous situation, these ruptured fibres cicatrize:

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might be injurious to the system. It may also be remarked, that those persons who perspire but little, are more inconvenienced than others by the heats of summer.

whence proceed those white striæ which are constantly seen upon the skin of the abdomen in women who have born many children. Another effect of distension is the production of wrinkles and folds, more or less distinct, according to the elasticity of the skin; and, consequently also, in proportion to the age of the subject.

We meet with, on the free surface of the teguments, different kinds of developments, more or less considerable, and which present various forms. They are situated in the dermis, of which they appear to be an accidental formation. They are commonly termed *warts*. Syphilitic growths appear more often to arise from the vascular net than from other parts of the dermis. The horny productions of the skin, of which there are several kinds, are sometimes met with upon the tissue of cutaneous cicatrices.

Others have also been seen to arise from the sebaceous follicles, but the most common are those, which, in consequence of continued friction, form in the epidermis, or are rather merely a development, with induration of this latter: such are *corns*, little hard, roundish, and horny productions; which, situated at first on the surface of the dermis, occasion very acute pains, by compressing its vasculo-nervous layer; they often penetrate its substance, and even the subjacent tissue.

A collection of sebaceous matter, situated in the follicles of the same name, shews itself when it is but small in quantity, by the appearance of a black spot at the summit of these latter; compression will then give exit to the matter, under the form of a small worm. Wheu this has collected in a greater quantity, the opening of the follicle still existing, the small tumour which results from it is termed a

*pimple*; but when this latter is more developed, and when the orifice of the crypta is obliterated, the pimple then becomes one of those kind of pustules known under the name of *meliceria*, *steatoma*, *atheroma*, names which refer merely to one complaint, and only indicate the consistence of the matter contained in the pustules, according as it resembles that of honey, suet, or pap.

In chronic complaints, accompanied by marasmus, the skin seems to participate in the general derangement, and presents a certain roughness, a dingy earthy appearance, very common in those suffering from phthisis. This membrane appears also susceptible of presenting, after a continued irritation, a kind of local hypertrophy.

Solutions of continuity of the skin unite either immediately (there is then effused a plastic matter between the lips of the wound placed in contact) and without leaving any traces; either by an intervening substance, that is, by the formation of a new tegumentary membrane over the surface exposed by the separation of the edges in the solution of continuity; or by the loss of a portion of the skin. In this latter case, there is observed the same process of cicatrization as described in the first chapter, the cellular tissue being the seat of this. When this process is completed, the skin is found supplied by a very analagous tissue to its own, but which differs from it, however, in some respects, and is always easy to recognise. In fact, this tissue is denser, less vascular than the primitive tegument; it does not generally present papillæ; but its external surface, commonly united and shining, sometimes presents irregular figured edges.

As to the colour of the cicatrices, it is paler than that of the skin in white nations (if it is not immediately after their

formation and in some particular cases) ; but among negroes, it is first of a rosy white, and approaches more and more to that of the surrounding parts, with which it is ultimately confounded at the expiration of a longer or shorter period.

When the epidermis alone is destroyed, it is more quickly reproduced, unless the subjacent layers, too greatly irritated, suppurate; a circumstance which retards for a varied period the formation of a new epidermis; and may even modify the skin, so as to give it the appearance of newly formed teguments.

Inflammation of the skin assumes a great variety of forms, according to the part which it attacks, its cause, the intensity of this morbid condition, the nature of the secreted product, &c.

Even to this time the anatomical characters of cutaneous inflammations have been but little studied ; their external appearances alone have been observed ; and it is from these forms, with frequently an erroneous knowledge of the cause, that this order of complaints has been classed. From hence it results, that we at present possess but very imperfect data upon their true pathological anatomy.

Inflammations of the skin termed *erythema**, that is, those which constitute erysipelas, the red patches in scarlet fever, those which succeed the first effects of a burn, the action of rubefacients and blisters, are characterized by the vascular injection, either of the superficial layers or of the whole thickness of the skin, injection manifested during life, by more or

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* From ἐρύθημα, redness.

less bright and sometimes violet redness, and by the diffuse tumefaction of the affected organ. When the inflammation is slight, the redness disappears upon pressure, and re-appears when this latter is withdrawn; the complaint dies away, and the epidermis falls off in furfuraceous scales; or, should the patient die in consequence of other injuries, no traces of inflammation are met with after death.

But when the disease is more intense, the dermis (and principally its superficial part) is penetrated by much blood, swelled, often shining, and exhales, according as the inflammatory state is more or less intense or continued, a serous yellowish fluid, or pus. This is what is particularly seen in cutaneous inflammations produced by blisters; the first effect of the inflammation which they occasion, is a serosity which raises the epidermis; from hence the vesicles and serous effusion. The former, ruptured, spontaneously or artificially, subside, fall in shreds, and leave exposed the inflamed dermis, the secretion of which becomes purulent when it puts on this morbid state. In those cases where the inflammation is intense or long standing, it leaves traces after death; that is, the dermis is found more or less injected, thickened, indurated in the corpse, and sometimes penetrated, and, as it were, combined with the blood which fills its vessels; a gelatinous fluid occupies, in some cases, its areolæ.

The most internal meshes of this tissue are deprived by inflammation of the fat which they contained. Lastly, the subjacent cellular tissue is frequently œdematous; sometimes also inflamed, and penetrated by a purulent liquid (phlegmonous erysipelas). Gangrene is sometimes the termination of certain cutaneous inflammations, excessive or determinate by an exciting cause; in this case, the surface

of the affected skin appears of a livid or violet colour, surrounded by a yellowish tinct; vesicles cover it, and after their rupture the denuded dermis presents small dark points already gangrenous, which extend and invade very quickly a greater or less extent of the diseased part, and even of the subjacent tissues. Scarifications of the skin, applied in cases where there is an excessive œdematous infiltration, produce very often and rapidly gangrene of this membrane*.

We must refer to gangrenous inflammations of the skin, that which constitutes the malignant pustule; a circumscribed inflammation occasioned by specific contagion, and characterized by the presence, in the thickness of the dermis, of a gangrenous, hard, reddish, and homogeneous eschar, inclined to spread on the surrounding skin and subjacent tissues. This membrane, in the diseased part, is livid, œdematous, and filled with vesicles which contain a reddish serosity.

Furuncles would appear to be also, according to common opinion, a cutaneous gangrenous inflammation, which is characterized by the presence, in the dermis or even in the subcutaneous cellular tissue, of a whitish eschar, or sore, termed *bourbillon*, which results from the mortification of a portion of skin or of cellular tissue, strangulated by the inflammatory swelling of the parts which surround it. It is difficult to admit the gangrenous nature and the strangulation of the bourbillon; for, as M. Gendrin observed, this latter

* It would appear, from the observations of M. Andral, jun. that the congestion of the venous blood in the dermoidal tissue, is sufficient to determine gangrene of this latter, when it is very slightly inflamed, or even when it presents no appearance of inflammation; this is what that author has observed in some affections of the heart, where the interruption of the venous circulation was excessive.

does not present the characters of eschars of the cellular tissue, and they are met with at the time when the inflammatory swelling, still slight, is not able to occasion this pretended strangulation. It is more probable that the matter of furuncles and carbuncles arises from a peculiar secretion, the product of which is deposed in the areolæ of the dermis.

The skin is subject to some acute specific inflammations, characterized by the development of pustules more or less numerous. The principal are the various kinds seen in small pox, cow pox, and measles.

The pustules of the true small pox are situated in the substance of the dermis, which, around them, is injected, and sometimes infiltrated by serosity. They present at their period of development an external, flattened, and umbilicated form, and an internal areolar disposition. When they are absorbed at this period, the skin does not retain any cicatrix; or at least it is very superficial: this is what takes place for the most part in all pustules when they are but few and insulated (distinct small pox); but when they pass on to suppuration, their substance is converted into a little ulcer, which leaves behind it a depressed and rugged cicatrix, redder at first, and afterwards paler than the surrounding integuments; this occurs in that species of small pox termed the *confluent*, where the pustules are very numerous and run into each other; in this case, the skin is swelled, often becomes œdematous, and presents sometimes gangrenous spots. The fluid contained in the pustules before they suppurate, is at first serous and limpid, then thicker and whitish. Inoculation with this matter communicates the small pox. Certain conical or flattened pustules, but situated only on the surface of the dermis, and leaving no cicatrices, constitute varicel-

lous or pseudo-variolic eruptions, and the modified small pox of vaccinated subjects, and of those who have had the true small pox.

The inoculation with the vaccine lymph, by means of a lancet introduced beneath the epidermis, is followed by the development, from the punctured part, of a round pustule, embedded in the epidermis, projecting from the surface of the skin, depressed at its centre, and surrounded by a red areola.

This pustule contains a serous and limpid fluid, spread in small cells, which divide into radiating and concentric partitions. It dries and forms a crust, preserving its round and umbilicated form: after its termination, there remains at the place which it occupied a superficial and pointed cicatrix, more rosy at first, then whiter than the surrounding skin. The vaccine pox is not genuine when the puncture is followed by the development of a simple vesicle without areolæ, rising above a little tuberculous eminence, and disappearing without leaving any marks. Inoculation with the vaccine lymph often occasions, among those already vaccinated, pustules, which differ only from the true by one anatomical character, that is, their situation on the surface of the dermis; the matter which they contain will answer for vaccination. In measles, the pustules are very small, sensible to the touch; around them, the vascular net, not the dermis, is inflamed.

Ring-worms are chronic cutaneous inflammations, very varied in their form, the anatomical characters of which still remain to be elucidated.

The superficial or sub-cutaneous layers of the epidermis appear to be the seat, at least at first, of the greatest num-

ber of them. M. Gendrin considers their origin to be in the sebaceous follicles. The different kinds of tinea (scald-heads) appear also at first to attack the surface of the skin, and to propagate themselves from hence into the substance of this membrane.

It has been long since observed, that one species of this disease, the *tinca favosa*, has its seat in the sebaceous follicles and roots of the hair. The skin is susceptible of fibrous and cartilaginous transformations. It has been seen to assume the anatomical characters of mucous membranes, in parts which had ceased for some time to be connected with the external world.

The excessive development of the vascular tissue is the cause of certain congenital spots (as *nævi, envies*), of a more or less reddish or violet colour, similar to the skin. Some species of these spots result from a congenital or acquired change of the pigment. The total absence of this latter is seen among those individuals called Albinos, and which gives to the external tegument a whiter appearance than that which it has generally, with a slight rosy tinge, owing to the presence of the blood.

## SECTION III.

### OF THE INTERNAL TEGUMENTARY SYSTEM, OR OF THE MUCOUS MEMBRANES.

SYNON. Glandulous membranes, internal membrane of the intestinal canal, of the nasal fossæ, &c. Pituitary membrane in these latter. Villous, villous-papillary membrane, &c. in the digestive apparatus.

*Definition.*—Under the generic name of mucous membranes is comprised all the parts of the tegumentary system, which, being a continuation of the skin, penetrate into the interior of the body, and line the cavities of the latter, open on their external parts.

*Division.*—The internal tegumentary system presents two non-continuous parts, and opening, each separately, externally. The one is the mucous membrane which lines the alimentary canal from the mouth to the anus, the air passages, &c. and which presents one principal part and several prolongations, of which we shall presently speak. The other part comprises the genito-urinary mucous membrane.

*Situation and disposition.*—The internal tegument of the first division lines the mouth, where it is continued with the skin of the lips; it then successively covers the pharynx, the œsophagus, the stomach, and the intestines; at the ex-

tremity of which it is again continued with the internal tegument. In this course, it furnishes several prolongations, namely: 1st. that which, behind the mouth, proceeds to line the nasal fossæ and their sinuses (pituitary membrane), presents an external communication with the margin of the nostrils, where it meets the skin, penetrates higher up the nasal duct, and covers a part of the globe of the eye and the internal surface of the eye-lids, at the free extremity of which it gives place to the cutaneous tegument: 2d. that which penetrates into the eustachian tube, the cavity of the tympanum, and the mastoid sinus: 3d. that which, from the inferior part of the pharynx, dips down into the larynx, the trachea, the bronchia, and all their ramifications: 4th. those, lastly, which, from the different points of the alimentary canal, are conveyed into the excretory canals of the glands contiguous to it.

In man, the genito-urinary mucous membrane commences at the base of the glans penis, which it covers, dips down into the urethra, and, after having lined this canal, covers the internal surface of the bladder, the ureters, the pelvis of the kidneys, and also the renal capsules.

In woman, it commences at the internal surface of the great lips, and, after having covered the clitoris and the whole of the vulva, one part of it penetrates into the urinary passages, which it lines as in man, and the other enters the vagina as far as the neck of the uterus, upon the internal surface of which it is reflected: it is not distinct in the cavity of this organ; its existence is only suppositious.

*Conformation.*—The form of the internal teguments results, like that of the whole system to which they belong, from the conformation of the parts which they cover. Some-

times this form is modified by the numerous folds which these membrane in many places present. The most considerable of these form true partitions, composed of two layers of mucous membrane, contiguous by their adherent surface, and between which are found cellular tissue, vessels, and muscular fibres. The curtain of the palate and the ilio-cæcal valve are examples of these duplicatures.

Other permanent folds, like the preceding, but much smaller, are found in great numbers in the small intestines, under the name of *valvulæ conniventes.*

Lastly, there are met with, in many parts of the internal teguments, simple pleats or folds, which allow of these layers accommodating themselves to the increase of size of the organ which they cover. Among these folds, those of the stomach are distinguished by their volume, those of the vagina by their regularity.

*Surfaces.*—Of the two surfaces of mucous membranes, the internal is free, and the external adherent. The former presents small irregularities, formed, some by eminences, known by the names of papillæ and villosities; others by small depressions, which constitute principally the mucous and phaneric follicles.

The papillæ are little conical eminences, appreciable only in some parts of the internal teguments, but especially on the superior surface of the tongue, at the base of the glans penis, and at the clitoris: they are formed by all the layers of the mucous membrane. The villosities belong almost exclusively to the gastro-intestinal membrane, and are particularly remarkable in the stomach, and still more so in the duodenum and jejunum.

The villosities are little foliaceous projections, of variable

size, but generally larger at their free extremity than at their points of insertion, and formed by the entire thickness of the membrane, at the surface of which they give, by their union, the appearance of velvet. These little prolongations are shorter and thicker in the stomach and duodenum, longer and more narrow in the jejunum and commencement of the ilium. They are disposed in nearly parallel lines. Some observations have led to the belief that, at the free extremity of the villosities, there are little orifices which should correspond, according to this view, to the open origins of the capillary vessels. The follicular depressions, which are remarked at the free surface of the mucous membrane, are sometimes simple porous orifices; at other times, excavations. Besides the follicular depressions of mucous membranes, the history of which will be treated of under the head *Structure*, there are others which are much developed in the stomach of ruminating animals, where they form small alveolæ and cells more or less extensive; of no great importance in man, and are only perceived by the aid of a microscope in some parts of his alimentary canal. The adherent surface of mucous membranes presents projections formed by the follicular depressions of these organs: it is very intimately united to a moderately dense layer of cellular tissue, of which we have already spoken (Chap. I). This layer, which forms one of the tunics of the hollow organs, and has received the very improper name of *nervous tunic*, gives attachment to the muscular fibres of these organs; besides, it adheres to the periosteum, to the perichondrium, or, lastly, to some other fibrous or fibro-cartilaginous organ. This occurs in the air passages. In these cases, the adhe-

sion is generally very intimate, so much so, that it is sometimes impossible to separate the mucous membranes from the subjacent parts; whence the name of fibro-mucous membranes. We have seen that, in the folds of the internal teguments, this surface was contiguous to itself; without ceasing, nevertheless, to be lined by a layer of cellular tissue, and sometimes by a set of muscular fibres. Lastly, this surface is in contact with a great many vessels and nerves.

*Structure.*—There are great differences observed under the form of the organization, not only between the external and internal tegument, but also between the different parts of this latter. Thus the mucous membranes do not present any part, possessing in a very evident manner all the layers which enter into the structure of the skin; also, the number of layers which it is possible to distinguish are not the same in the different parts of these membranes: lastly, the anatomical characters of these layers vary themselves according to the portion of the internal tegument examined. Under the first head, we may remark, that no part of the mucous membranes presents a distinct reticulated body, and that we can never recognize but two layers in their composition, the *chorion* and the *epidermis*. Under the second head, we may observe, that this last layer, which is here called the *epithelium*, does not exist, or at least is not perceptible, except in certain parts, as those from the mouth to the end of the œsophagus, from the vulva to the neck of the uterus, and, in general, in those placcs where the mucous membranes are continuous with the skin to a certain distance from these points of origin. As to the differences which exist between

the two layers which form the internal teguments and the corresponding layers of the external envelop, the following description will give a general idea.

The *chorion,* or *mucous dermis,* belongs exclusively to the whole gastro-intestinal mucous membrane, to the whole extent of the urinary passages, except at the vicinity of the external orifice of the urethra, to that of the frontal and mastoid sinuses, of the tunica conjunctiva of the eye, and of all the excretory canals. It presents itself under the form of a soft spongy substance, without any apparent texture, unless near the surface of the skin. The layer which it forms is in general thinner and less dense, the further it proceeds from this latter membrane: it is particularly of an extreme tenuity in its prolongations, as in the excretory canals. The mucous dermis is very vascular, and that proportionate to the very varied number of the follicles, the papillæ, and villosities, which it presents in different organs. As to the nerves of this layer, they can be traced only in certain parts: as in those where there exist the pituitary membrane, &c.

These latter eminences belong to the tissues which we are now describing. The papillæ are formed by the sanguineous capillaries and the nervous filaments of the surface of the chorion, maintained by the proper tissue belonging to this latter. The disposition of their venous capillaries renders them erectile; a property very appreciable in the papillæ of the tongue during gustation*.

The villosities are composed of lymphatic and sanguineous

* There is seen, between the dermis and epidermis of the lingual papillæ, an effused substance, which perhaps is analogous to the mucous layer of Malpighi. This substance does not contain any pigment.

capillaries, frequently anastomosed together, jutting out on the free surface of the mucous dermis, and accompanied and sustained, like the papillæ, by their own proper substance.

The *epidermis* of the mucous membranes is found only, as we have seen, in certain parts of the internal tegumentary system. In those where it does not exist, and especially over the intestinal villosities, a layer of diffluent matter covers the chorion, and appears to succeed the layer of which we are speaking, which is itself, perhaps, nothing more than this matter in a dried state. As to the rest, the epidermis is thicker in those points surrounded with papillæ, and especially upon the tongue, than in any other part, and becomes gradually thinner as it is more remote from the skin.

The *mucons follicles*, or *mucoid glands*, are formed, like those of this latter membrane, by the depression of the internal tegument, and represent small cysts with a very narrow neck, opening on the free surface of the mucous by a funnel-like orifice. The follicles are moderately scattered over the internal cutaneous system; but their very variable size does not allow of their existence being every where recognized with facility. They are found sometimes insulated, and at other times collected in a greater or less number. In this latter case, they sometimes open separately on the surface of the mucous membrane; sometimes they proceed together to form one or more depressions, commonly termed *gutters*, which serve as excretory canals*: the tonsils are only follicles collected in great numbers. It is the same also

* There is then a previous depression which constitutes the groove, and secondary depressions of the parietes of this latter, which form the follicles.

with the prostrate and Cowper's glands. There are also found, less numerous agglomerations of mucous cryptæ, at the great angle of the eye, under the name of *carunculæ lacrymalæ;* others, still less considerable, in the navicular fossæ of the ureter, at the root of the tongue, &c. The grooves into which they empty themselves are much developed. The epidermis, where it exists, penetrates the excretory canal of the mucous follicles. The sub-mucous cellular tissue is more vascular in the parts corresponding to the follicles than in the intermediate points to these organs; that is, these latter receive many vessels. We can also trace these nervous filaments in the parts of the internal teguments, which themselves exhibit any.

We shall refer to that section which treats of the appendages of the intoguments, the history of follicles of mucous membranes, the products of which are solid (as the teeth), and arise from the surface of these latter.

*Physical and chemical characters and properties.* — The colour of mucous membranes varies from a very lively red or rose, which is that which they generally present on the surface of the skin, and particularly on the lips, the tongue, in the posterior part of the fauces, the internal surface of the eye-lids, upon the glans penis, the vulva, &c. to that of a rosy or greyish white, which constitutes the colouring of the greatest part of the teguments of the alimentary canal, the urinary passages, &c.

The bile communicates, to that portion of mucous membrane with which it is in contact, a yellowish tinge, more distinct after death than during life, in consequence of the greater activity of the imbibition of the fluids in the dead body.

The thickness and density of the internal teguments vary extremely: they are generally thicker near the skin (if we except the conjunctiva, which is very thin), from which they progressively diminish. The mucous of the ultimate bronchial ramifications, that of the greatest part of the excretory canals of the glands, and that of the frontal and maxillary sinuses, possess in the least degree these two latter characters. In general, the internal teguments possess a soft and spongy consistence, which gives them very little tenacity. For the same reason, they are very hygrometrical.

These organs are essentially gelatinous; their putrefaction soon takes place. Acids dissolve mucous membranes: concentrated sulphuric acid reduces them to a black pulp; pure nitric acid gives them, especially the lips, the pharynx, and the œsophagus, a yellowish orange colour, before it dissolves them. It is important to notice here this character; because it constitutes one of the symptoms of poisoning by this acid: but it belongs equally to other organic solids.

*Vital properties.*—Mucous membranes are generally sensible; but this property, obscure in the greatest part of their extent, is, on the contrary, more acute among those near the external teguments, and very much so in the mucous membranes of the mouth and nasal fossæ, to which are distributed the nerves of special sensations, of taste and smell. The sensibility of the cutaneous membrane of the glans penis and clitoris are equally exquisite. The tegumentary tissue possesses slight vital contractions.

*Varieties from age.*—In the fœtus the mucous membranes are extremely thin and soft to the touch; their papillæ not being yet prominent, their colour is then rather of a violet than reddish hue; their adhesion with the subjacent tissues

is easily destroyed. The teguments of the intestinal canal contain at the same period a brown matter, similar to poppy juice, and for that reason termed *meconium.*

After birth, the internal teguments still preserve for some time their softness ; they have generally a rosy tinct, more lively in infancy and in youth than in the succeeding ages : periods, when the pale mucous membranes, among others those of the alimentary canal, of the bladder, &c. have exchanged the slight rosy shade which they had, for a greyish tinge. In old age the mucous membranes become denser, and lose part of their velvet-like appearance.

*Functions.*—The mucous membranes are essentially the organs of absorption, a function which they perform in virtue of their delicacy, the fineness of their epidermis, and the absence of that layer in the greatest portion of their extent : the presence of the vascular villosities which they present in the digestive apparatus renders absorption very active.

These membranes are also the organs of serous and mucous secretions. This latter species belongs especially to the follicles, the products of which vary much. The mucosity, or the mucous fluids, very different, according to the parts of the internal tegument where they are met with, contain likewise throughout an animal mucus, which forms their basis*.

Some mucous membranes are the seat of particular sensorial impressions, arising from the specific nerves with which they are supplied. Thus, the sensation of hunger is refer-

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* It is impossible to give an accurate analysis of these humours ; because they are frequently mixed with other fluids secreted by the glands, such as the tears, saliva, bile, the pancreatic juice, and the urine.

rible to the muco-gastric membrane; that of taste to the mouth, especially to the papillæ on the surface of the tongue; the mucous membrane of the nasal fossæ receives the impressions of smell.

There exists a very intimate connection, both physiological and pathological, between the mucous membranes and the skin, the circulatory apparatus, the nervous system, &c.

## MORBID ANATOMY.

Mucous membranes participate in irregularities of conformation, either congenital or acquired, as well as in displacements from the organs which they cover. They may also present particular deformities; as occurs, for example, in those cases where, in consequence of hernia, these membranes are protruded by the subjacent tissues.

When a mucous canal ceases to be supplied by the fluid to which it afforded a passage, it suffers a contraction more or less considerable; when, on the contrary, this fluid is more abundant than usual, it may much dilate the mucous membrane, which returns but very slowly to its original form, even after the cause of its distension has ceased to act for some time. We shall see that inflammation may also alter, in different ways, the form of the internal teguments. The tissue of their cicatrices differs only from them by being of a paler colour, and possessing more resistance.

Inflammation of mucous membranes is very frequent; it is generally characterized by a colour which varies from a rose to a deep brown, and presents itself sometimes under an aborescent form: sometimes under that of points more or

less red, scattered upon a pale or rosy bottom (this is when the villosities alone are inflamed, or are more so than the intermediate points); sometimes also under that of uniform spots, most frequently red; sometimes violet, or livid; sometimes also of a greyish slate or brown colour*.

Besides the change of colour, the mucous layers present also an increase of thickness. At the same time, this organ loses its resistance, becomes softer, and is easily detached from the subjacent tissues. Its secretion, which is more active at the commencement of the inflammatory state, furnishes then a less viscous production, more or less puriform, sometimes only more abundant or more serous than usual; but, when the inflammation has attained its height, the mucous secretion is arrested until this latter begins to decline; the production of this function is then often puriform, and even purulent, without there being any ulceration of the diseased part; at other times the inflamed mucous membranes secrete a matter which coagulates and deposes itself on their free surface, under the form of false membranes, more or less thickened; it is the presence of similar productions in the larynx, which characterizes the species of laryngitis known by the name of *croup.* False membranes are also formed in certain cases of pharyngeal and tracheal cynanche, in some inflammations of the mucous membranes of the bronchia and intestinal canal, and more rarely in that of other membranes of this kind.

These productions are susceptible of becoming organized

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* The inflammatory arborescent colouration is that alone which yields to washes and maceration: all the others experience from this latter only a slight diminution of intensity.

similar to the serous membranes; but that happens but rarely, since they are most frequently rejected early by vomiting, purging, &c. or because the patient dies before their organization is completed. At other times, the inflammation diminishing, the internal tegument secretes again a liquid which then displaces the false membrane, and completely detaches it; or the secretion not having taken place, the morbid product gradually becomes thinner and semi-transparent, and finally disappears. Ulceration of mucous membranes may result from their acute inflammation. In these cases their margins are slightly elevated, very red, and surrounded, as well as their base, by a puriform mucous substance. These inflammations terminate also sometimes in gangrene, either in consequence of their violence, or because they have essentially a phagedenic character, as that which is seen in the epidemics of putrid sore throats. The development of little vesicles upon the diseased part sometimes announces this termination. The eschars of mucous membranes vary from a grey to a brown black, and generally present the appearance of a putrid deliquium. We find among many who have died with those symptoms which denote mucous fever, an inflammation of the cryptæ of the internal gastro-intestinal tegument: inflammation which produces true grey or whitish pustules filled with a muco-purulent liquid; at the centre of these pustules, there is remarked a depression, or a little black point, which indicates the orifice of the crypta. This affection has been principally described by Ræderer and Vagler.

M. Bretonneau, of Tours, has also carefully studied the *granulated* (*boutonneuse, button-like*) inflammation of the follicles, both in connection with, and separated from, the intes-

tinal mucous membrane, a disease to which he gives the name of *dothin-enterite,* which readily assumes a chronic character, and often produces ulceration of the diseased cryptæ. There has also been noticed pustulous inflammations of these membranes in cases of small pox; the pustules, generally very superficial, situated sometimes however in the substance of the chorion, are not constantly depressed, and do not appear to have the areolar disposition of those of the external tegument.

Chronic inflammations of mucous membranes have for their common character a redness generally very slight, often copperish* or livid, at other times almost colourless; a thickening with an increase of density in the affected part, the tissue of which is more homogeneous than in the original state. The vegetations which are observed on the surface of mucous membranes result from a developement of their capillary vessels, occasioned by a prolonged irritation, or by chronic inflammation. Ulcerations produced by this latter are characterized by a hardness, an elevation, and irregularity of their edges, which are sometimes sloped perpendicularly, or downwards, with fungous. The base of the ulcer is rugged, of a more or less livid or copperish colour. A secretion of puriform or purulent matter generally accompanies this morbid condition, even though no ulceration exists. It is also to a prolonged irritation, or chronic inflammation, that we must refer polypous excrescences, &c. which are sometimes observed on the free surface of the internal tegu-

* The colour here resists still more the effects of washes and maceration, than in cases of acute inflammation.

ments; the erectile productions which accidentally develop themselves in their substance, as well as the osseous and cartilaginous transformations of these membranous organs.

These latter are very frequently the seat of sanguineous congestions, either active or occasioned by the irritation of their tissue; either passive or produced by some defect in the circulation. In these cases, bathing the membrane will restore its original colour. We do not perceive any morbid product on its surface: its thickness, density, and consistence, are in their ordinary condition. These congestions may occasion an hemorrhage on the surface of the mucous membrane, or even an inflammatory action. We sometimes find pilous and horny productions on the surface of mucous membranes. When these are exposed for a certain time to the atmosphere, they assume the characters of the external tegument.

The membranes which line fistulous canals, certain cysts, and the greatest number of purulent abscesses, may be referred to the order of the mucous membranes.

## SECTION IV.

### APPENDAGES OF THE TEGUMENTARY SYSTEM.

We name thus, the solid parts produced by the bulbous or *phaneric* follicles, and which project from the free surface of the teguments. These parts are: the hair and the nails, belonging to the external tegumentary system, and the teeth, to the internal. Before we enter into any particular description of each of these products, let us give a general idea of the productive part, or the *bulb*, or radicle.

The bulb is a small vesicle, situated in the substance of the dermis, projecting from the adherent surface of the latter, and being continuous by the extremities of its orifice with the tegumentary membrane, of which it is merely a depression, and which it also resembles in its anatomical characters: in fact, this little organ is composed—1st. of an analogous layer to the dermis, in connection with the sub-tegumentary cellular tissue, giving passage, in the interval of its fibrillæ, to vessels and nerves, which ramify principally on its concave surface; 2nd. of a matter more or less pulpy, which is formed like the termination of the vascular and nervous parts of the preceding, and represents the mucous net of Malpighi (the pigment is found here in some cases, as we shall see); lastly, the part produced, lifeless and inorganic, is analogous, in this respect, to the epidermis, and sometimes also in its chemical composition.

## ARTICLE FIRST.

## THE HAIR, OR PILOUS SYSTEM.

*Definition.*—The hairs are inorganic filamentous parts, of a very variable length and fineness, which arise from the free surface of the external tegument.

*Division and situation.*—Different names are given to the hairs, according to their situation.

Those in great number, which cover the greater part of the scalp, are known by the general name of *hairs;* those which are collected upon the orbitary arches are the *eye-brows;* the *eye-lashes* surround the free edges of the eye-lids; the *whiskers* descend from the ear upon the sides of the cheeks; the hairs on the chin are termed the *beard,* and those on the upper lip *mustaches;* lastly, the generic name of hair refers also to all those pilous productions spread over the surface of the body and the extremities, and of which we find considerable quantity in the arm-pits and over the pubis.

The palms of the hands and soles of the feet are deprived of hairs: they are rare upon some parts of the face, at the internal part of the limbs, and on the back; they vary more or less in different individuals, and especially according to the sex, at the sternal portions of the thorax, and external parts of the extremities.

*Form.*—The productive part, or the pilous bulb, represents a small ovoid vessel, open at the free surface of the teguments.

The hair has, properly speaking, a conical form; that is, it is finer at its free extremity than at that which is connected to the bulb. It is sometimes nearly straight, and at other times folded upon itself, or curled.

*Structure.*—The productive bulb of the hair is nothing more than a small depression, more or less oblique, of the cutaneous tegument, in which we find all the layers of this latter. The pigment also exists in the part which represents the reticulated body. A little cone of pulpy matter fills the greatest portion of the bulb. Upon this papilliform body is implanted the inorganic part or product, the hair itself.

At its adherent surface the pilous follicle presents nervous and vascular filaments, which resemble little roots. The hair itself embraces by its base, which is hollow and diffluent, the pulpous cone of the bulb; besides, the surrounding epidermis, after having lined the orifice of this latter, is reflected over the same base, and is confounded with the hair*. This follicle is a colourless epidermoid sheath, containing a coloured substance disposed in filaments more or less numerous, between which is found a fluid matter, destined to unite them together and with the sheath. This internal coloured portion represents the mucous layer of the skin: it is to its presence that the hairs owe their colour. The hairs

* This double mode of union of the hair with the skin renders the adhesion of these two kinds of organs sufficiently intimate, so as not to be ruptured, except with some pain and a little difficulty.

All the causes capable of detaching the epidermis from the subjacent layers have the same effect with respect to the hair.

have neither vessels nor nerves: their bulbs alone receive them.

*Physical and chemical characters and properties.*—The colour of the hair varies, in different individuals, from the fairest white to the deepest black, in passing through varieties in shade, as auburn, red, brown, &c. There are some colours, as blue, green, yellow, &c. which it never presents. Hairs are white upon the parts of the skin which have no pigment, as is seen in albinos. Generally, their colour is the same in individuals over their whole body; however, there are some exceptions to this. The thickness or the diameter of the hair is very different even in the same person, according to the part which they occupy: thus, those of the pubis are the thickest; then those of the armpits, the hair of the head, the eye-brows, eye-lashes, beard, &c. The white are generally the finest, and the black are the thickest. Pilous productions greatly resist their transverse rupture; but they easily divide in length. They are solid and dry on their external part, soft internally, and fluid at their adherent extremity.

Hairs rapidly absorb moisture and swell. They resist for many years putrefaction. A prolonged decoction in Papin's digester dissolves them, and reduces them to mucus, after having disengaged sulphureted hydrogen gas.

According to the analysis of black hair, made by M. Vauquelin, this latter contains a great deal of animal matter analogous to mucus; a white concrete oil; a little oil of a greenish grey, thick like bitumen; traces of the oxides of manganese and iron, and of sulphate of iron, silica, sulphur, and also the phosphate and carbonate of lime. The

colour of the hair depends, according to this chemist, on the presence of a greenish oil, and sulphate of iron. In red and light hair, the first would be supplied by red or yellow oils: it would be more or less blended with these latter in brown hair, &c.

*Vital properties.*—The bulb of hairs, and particularly the pulpous part, alone possesses some sensibility; whilst the part produced is completely deprived of vitality. The motions which the hair sometimes presents depend on the contractions of the cutaneous system.

*Differences according to the races.*—The varieties in colour we have pointed out, belong, almost exclusively to individuals of the Caucasian race; and, among these latter, we may remark that those who inhabit northern climates have generally a pilous system less coloured and fairer than those of the southern regions. In all other races the hair is black. The hair is long, fine, very abundant, and often curled, in the Caucasian and Malayan tribes; fine and scanty in the American; short and thick in the Mogul; frizzled or curled, and woolly, in the Ethiopian.

*Varieties from age and sex.*—The skin of the fœtus is covered, about the middle of pregnancy, with a down or wool of extremely fine hairs, which fall off before birth, and the remains of which are seen in the *liquor amnii*. The hairs, the eye-lashes, and brows, are among the permanent pilous parts which are first developed: they exist from the last months of gestation. The other hairs do not appear until about the age of puberty. The pilous productions are in general finer, and of a lighter colour in infants than among adults. In the decline of life, and sometimes before, the hairs lose their colour and fall off: those in old men become

white and scarce. In women we generally observe neither a beard* nor whiskers; and the hairs scattered upon the breast and at the external part of the extremities are very scanty and fine.

*Functions.*—The pilous bulb secretes the substance which forms the hair: this latter is a defensive organ for the skin; it serves also for tactile sensations, by the facility with which its productive pulp receives the impression of bodies which touch it in any portion of its extent.

## MORBID ANATOMY.

When the hairs are drawn out, they are reproduced, provided their bulb or radicle has not been injured: the same thing takes place after the termination of diseases of the pilous system which occasion the loss of these productions.

Sometimes the bulb is altered by a continued inflammatory condition, or in some other way; its pilous secretion then ceases entirely, and the hairs also lose their colouring matter. This last phenomenon is, as we have said, a natural result of age: in this case, it comes on gradually, and the hairs are not all discoloured at the same time; but often, and principally in consequence of certain moral excitements, such as fright, &c. the hairs suddenly become white before the ordinary period.

It may then happen that they will resume their primitive

* Some females, however, present this appearance, especially upon the upper lip, either about the time of puberty, or after menstruation has ceased.

colour. We are not yet acquainted with the changes which take place in the follicles of the hair when they are destroyed or discoloured.

The name of matted is given to an affection, but little known to this day, in which the hairs acquire an unusual length, and interlace in an inextricable manner.

It has been stated that they then become vascular and sensible: perhaps there is no truth in this opinion, which is at least exaggerated. Béclard endeavours to account for the facts which occur (hemorrhage and pain which then accompany the section of the hairs) by supposing that, in consequence of the irritation which the bulb experiences in this affection, the pulp which secretes and which embraces the hair swells, is raised above the level of the skin, and is then entangled by the instrument with which we remove the affected part.

We sometimes meet with accidental pilous productions, the consequence of inflammations of parts of the skin which did not before present any.

Some cutaneous spots present also small collections of hairs. There are related many instances of hairs found in the organs lined by mucous membranes; but most frequently they appear to have been introduced there. Certain cutaneous cysts also contain some, which present the conditions of structure of original hairs. Lastly, we sometimes find in the ovaries, without there being either indication or possibility of extra-uterine pregnancy, very fine whitish pilous productions, completely free.

The hairs that some authors, as Bonet and Amatus, are said to have found upon the heart were probably only pseudo-membranous filaments.

## ARTICLE SECOND.

## OF THE NAILS.

*Definition.*—The nails are hard and transparent lamina, which cover the dorsal part of the last phalanx of the fingers and toes.

*Form and disposition.*—The nails are oblong, and curved, so as to mould themselves upon the part which they cover. They are divided into *root*, *body*, and *free extremity*. The *root* is posterior, and placed in a fold of the skin ; it is the thinnest and softest portion of the nail : the *body* is continuous with the root, which it surpasses in thickness. It presents, posteriorly, a white semilunar portion on its superior convexity, which is called the lunated or crescent-like part : in the rest of its extent, the body of the nail appears reddish, its transparence shewing the colour of the subjacent cutaneous tissue. The free or anterior portion, thicker still than the preceding, extends more or less beyond the dorsal part of the finger. When nothing is opposed to its growth, this part becomes very long, acquires more thickness, and assumes a curved form.

The nails present two surfaces ; the one convex, the other concave : both are adherent to the skin at their radical or posterior portions, and free at the anterior extremity. In the middle part, the concave surface is adherent, and the convex free.

The nails adhere in their whole circumference (except at their anterior portions) to the subjacent cutaneous layers,

by means of the surrounding epidermis, which is united, without, however, being confounded with them: besides, their root, lodged in a kind of furrow in the skin, becomes there intimately united to the latter. Under the root of the nail the dermis is whitish; whence the semilunar spot termed luna: beneath the central part, on the contrary, it is very vascular and furnished with papillæ.

*Structure.*—The nails are considered by some anatomists, particularly by Bichât and J. F. Meckel, as formed of superlatent epidermoid layers, the extent of which diminishes successively from behind forwards, in such a way that the most external represent the length of the nail, and the most internal the shortest portion. This is merely an explanation of the differences of thickness which these productions present in different parts of their extent.

Other anatomists, as Blancardi and M. Blainville, think that the nails are agglutinated pilous productions, and proceed, not from all parts of the skin to which these organs adhere, but also from bulbs or radicles similar to those described in the preceding article. The longitudinal striæ which are observed upon both surfaces of the nail, appear, in fact, to establish the analogy of these latter with certain horns, which result very evidently from the agglutination of a great number of hairs*. However, these are only opinions; and we cannot yet decide whether the nails are formed by a thick and horny layer of the epidermis, or whether they are produced by the pilous bulbs.

*Physical and chemical characters and properties.*—The nails

* These striæ are owing, according to some persons, to the presence of linear ranges of papillæ which the subjacent dermis presents.

are whitish*, semi-transparent, hard, flexible, and elastic. They are albuminous, like the epidermis.

*Vital properties.*—The nails do not possess any vitality.

*Varieties from age.*—The nails exist from the fifth month of the fœtal life; their thickness and consistence, at first but very inconsiderable, progressively increase, and are very great in old age. At birth they do not always reach the extremity of the finger, and rarely extend beyond.

*Functions.*—The nails in man serve only to protect the free extremity of the fingers. The custom of cutting them, common to most nations, renders these organs less liable to laceration.

### MORBID ANATOMY.

When a nail has been drawn out, or that its loss has been occasioned by a disease of the subjacent dermis, it is supplied by another, more or less similar to it, according as the productive part is healthy or altered. It may even happen, in this latter case, that regeneration will not at all take place.

The nails sometimes present excrescences, or an irregular thickness. They are found more brittle, thinner and larger, than ordinary, in scrophulous subjects, or in those suffering from some other chronic affections, as phthisis, &c. When the tissues which surround the nail rise above it, and cover a portion of its free surface, it is said to be *imbedded in the flesh*. This complaint, which is almost exclusively confined to the great toe (where it is occasioned by the use of narrow shoes), gives rise to acute pains, and even to inflammation of the skin in contact with the sharp edge of the nail.

* In coloured races the pigment is subjacent to them, and it is to their diaphinous condition alone, that their darkish appearance is owing.

## ARTICLE THIRD.

### OF THE TEETH.

*Definition.*—The teeth are calcareous organs, whiter and harder than the bones themselves, produced by the dependent follicles of the mucous membrane of the mouth, and situated in the alveoli or sockets of the upper and lower jaws.

*Number, division, form, and situation.*—(The history of the teeth, under these various characters, comprises details so very minute, that they can only be noticed here in a general manner: a more intimate notice of these organs belongs to descriptive anatomy.)

*Texture.*—The teeth present two very distinct parts: the one, the *organic* or *productive;* the other, the *inorganic* or *produced.*

The first consists–1st. in a membrane which surrounds every part of the tooth, concealed in the alveolar process or socket, and is continuous, over the edges of this latter, with the mucous membrane of the gums; 2d. in a nervous, vascular, pulpy substance, presenting the form of the tooth, and surrounded on all sides by the generated portion, except in one or more points, where it communicates with the preceding membrane by nerves and vessels.

The inorganic part moulds itself exactly upon the pulp, which it thus resembles in form; it is composed of two substances: the one, which constitutes almost the whole of the tooth, is named *osseous substance,* or more properly *the ivory;* it

is disposed in layers, and presents neither cellular tissue, vessels, nerves, nor the areolated texture of bones. The second substance, or the *enamel*, forms a layer which covers the preceding, but only upon the crown of the teeth; it is of a milky white, shining, semi-transparent, and harder even than the ivory, upon which it exactly moulds itself, becoming thinner in proportion as it approaches the neck of the tooth.

The enamel is disposed by undulated bands, closely united with each other, and obliquely directed with respect to the axis of this latter. It does not present any further traces of organization.

We see also, as relates to their organization, the teeth cannot be classed in the osseous system.

Besides this distinctive character, and that drawn from the completely external situation of their crown, a situation which no other original bone presents, we shall point out, easily, as we proceed, all the other differences which separate the dental apparatus from the passive organs of locomotion. On the contrary, this apparatus is naturally allied to the same system as the hairs, since it presents us already, like them, a follicular and productive pulpy part, and an external inorganic part. Chemical composition alone determines the difference of these two kinds of productions; and comparative anatomy teaches us the small importance that this character here presents, in showing that the beak of birds is analogous to the teeth in mammiferous animals.

*Physical and chemical characters and properties.*—The teeth are of a white colour, very slightly tinged with yellow, more so in their alveolar part. The crown is more or less shining, in consequence of the enamel which covers it. The hard-

ness of the teeth surpasses even the hardest of all the bones, the petrous portion of the temporal: a superiority which results from the teeth containing more calcareous salts than the bones. In fact, the ivory substance analyzed by M. Berzelius yielded 51,04 of phosphate of lime; 2,00 of fluate of lime; 11,30 of carbonate of lime; 1,16 of phosphate of magnesia; 1,20 of soda; and a small quantity of hydrochlorate of soda. M. Pepis found also a little gelatine. According to M. Berzelius, the enamel contains the same salts as ivory, but in different proportions. The phosphate of lime, among others, is much more abundant in it than in the ivory. According to Hatchett, Fourcroy, and Vauquelin, the enamel is composed of phosphate of lime, united with a very small quantity of gelatine.

*Developement, and varieties from age.*—The changes which the dental apparatus experience during life are very remarkable. And first, there exists in this respect two kinds of teeth: the one comprises the twenty which first arise from the gums, and which are called *milky teeth*, or those of primitive dentition. These *milky* or *temporary teeth* fall out about the age of seven years, to give place to others, which constitute the *permanent teeth*, or those of second dentition. The temporary teeth include eight incisori, four canini, or cuspidati, and eight small molares or grinders, to which are added, between four and six years, four other molares which do not fall out as the preceding, and ought to be reckoned among the permanent. At the age just mentioned, the first twenty teeth, having fallen out, are succeeded by twenty more corresponding teeth. The number of these organs, which is then twenty-four (including the four permanent molares), is increased afterwards to thirty-two by

the developement of eight other large molares, four of which appear very late (between eighteen and thirty years), and are on this account termed *dentes sapientiæ*, or wisdom teeth.

The dental follicles begin to appear about the tenth month of the fœtal life, but not all together. These are at first little round sacs, closed in all sides, lodged in the alveoli, composed of two layers, of which the external, thicker, adheres very intimately to the gums; and the internal, very vascular and thin, is a kind of net, which contains at first a reddish fluid, afterwards of a pale yellow. About the fourth month, there is perceived at the bottom of this little sac the productive pulp, which soon takes on the form which the future tooth will possess. About the middle of pregnancy, this pulpy kernel is covered by small lamina of ivory substance, which are soon succeeded by others, excreted, like them, on the surface of the pulp.

When the pulp is surrounded only by calcareous matter, in a small portion of its extent, it may be easily observed, by the facility with which it is separated from it, provided no organic bond unites them together. Later, this union no longer exists; but the separation is impossible, because the ivory substance embraces on all sides the productive nidus.

The part of this body, which corresponds to the triturant surface of the tooth, is the first which is imbedded in this substance; also, the plates of this latter are more numerous in this point than in the others: they are still less upon the sides of the dental crown; the roots are formed last, and are only prolongations of the body. The enamel is secreted and deposed on the surface of the crown, by the internal membrane of the sac: it is easily separated from the ivory

portion in the fœtus. About six or seven months after birth, the first teeth pierce the sac which encloses them, then the mucous membrane of the gums, with which are soon confounded the edges of the orifice of this sac or follicle: it is at this period that the root becomes developed.

The different kinds of teeth are neither formed nor appear externally simultaneously. M. J. F. Meckel established on this subject general rules, which are as follow: 1st. the different periods are regulated by the same laws, provided the follicle of the tooth, the germ of which appears soonest, is also that which first becomes developed, ossified, and pierced in the socket: 2nd. the similar teeth of the same jaw correspond sufficiently in this respect: 3rd. the inferior teeth appear before the superior, and the anterior before the posterior: 4th. the gradual development of the teeth in man corresponds to the permanent forms which are met with in the series of mammiferous animals.

The follicles of the permanent teeth appear successively to form from the eighth month of the fœtal existence; situated at first in the same alveoli as those of the milky teeth, upon which they are then placed, and with which they are united by their external layer. These follicles soon separate from the others, fall to their posterior part, and are themselves, afterwards, enclosed in separate alveolar processes, which are formed from slight depressions of the posterior parts of their old sockets; depressions which are converted into alveoli, by the formation of another partition, between them and the part occupied by the milky teeth. The loss of these latter arises from the obliteration of the vessels and nerves which unite them to the jaw; a phenomenon produced by the permanent teeth, which, in becoming developed, compress

these bonds of union, and destroy successively all the adhesions of the temporary teeth.

The pulp of the permanent or temporary teeth is so much the more abundant, as it is examined at a period more advanced towards dentition; at a later epoch, its vitality gradually diminishes, and is finally extinguished at an age more or less advanced, according to circumstances; the loss of the teeth is a consequence, more or less connected with the complete atrophy of their organic portion. On the other hand, friction destroys gradually the enamel, and the ivory is denuded. We sometimes then see this latter itself worn as far as the dental pulp: in this case, it is covered with a new osseous substance, softer than the first.

*Functions.*—The teeth serve various uses; the incisori and canini, to seize and to tear; the molares, to grind or triturate the food: however, these acts are not confined exclusively to either kind.

### MORBID ANATOMY.

The form of the teeth varies sometimes from the original shape, and that in a very diversified manner. The eminences which surmount the crowns of teeth may be more or less numerous or projecting than ordinary: the roots, or fangs, present sometimes the same kind of anomalies; either they follow unusual directions, or sometimes even those of the two contiguous teeth unite together.

We also observe species of hypertrophies and atrophies of these organs. The number of the teeth is sometimes less, but rarely exceeds what we have already stated.

In the latter case, it has even happened that a double series of these organs have been found. In general, the supernumerary teeth are more common in the upper than in the lower jaw. At other times, a third dentition is observed a long time after the second. We find also the teeth transposed thus, a molare in the place of a canine, &c.

Their direction presents also numerous and varied peculiarities. The development of these organs sometimes takes place in an irregular order; and we often see the continuance of one or more of the temporary teeth, when the permanent, which correspond to them, are already developed, and arise from the alveolar; also, the absence of the permanent is the cause of the continuance of the temporary.

When fracture of a tooth takes place, it cannot be reunited if the crown is broken; but, on the contrary, should it be the root, there is secreted an osseous matter by its membranous envelope, which consolidates the fragments.

Inflammation of the dental pulp is not common, and occasions very acute pains. It terminates sometimes by suppuration or by gangrene; often, also, this morbid condition produces caries of these organs; a disease which attacks principally teeth deprived of their enamel, and more frequently the molares than any others.

We may remark also, that diseases of the gums and maxillary bones influence considerably the health of the teeth.

We sometimes meet with accidental dental productions, chiefly in certain cysts of the ovaries.

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# CHAP. IX.

## THE GLANDULAR SYSTEM.

*Definition.*—The glandular system consists in a certain number of organs, more or less rounded, provided with ramified canals, uniting to form one single trunk, which goes to the surface of the teguments, and there effuses a particular liquid separated from the blood in the interior of these organs.

We consider only as true glands the following: the three salivary, the lacrymal, the liver, pancreas, kidneys, the maxillary glands, the testicles, and the ovaries*.

* The sebaceous and mucous follicles, those isolated as well as those collected in great numbers, as the muciperal glands of Peyer (in the ileum), or even those also which open by common conduits (lacunes), on the tegumentary surface—these fluids, we say, ought to be classed with those we are about to describe; organs which differ merely from them in being less complex, but which are, like them, only prolongations of the teguments. In a word, a very little attention will suffice to prove that there exists no essential difference between the tonsils, or prostrate, &c. and the lacrymal or salivary glands. On the other hand, the name of gland was given to a mass of parts which possessed only between themselves vague relations of form or texture. And, without noticing here the tongue, to which its rounded shape entitled it to form a part of the glandular system, we will mention—1st. the lymphatic gan-

*Situation and Disposition.*—The glands are found exclusively in the trunk, and are sometimes in pairs, and situated on each side of the median line (the lacrymal, salivary, mamillary, the kidneys, testicles, and ovaries); at other times they are single and placed upon that line, or upon one of its sides (the pancreas and liver). The excretory ducts of each kind extend as far as that of the teguments.

*Conformation.*—The form of the glands varies much; these organs are always more or less rounded, and sometimes flattened in one or more directions. They differ still more from each other in their size. What a difference under this head there appears between the liver, one of the largest organs in the body, and the lacrymal gland!

*Structure.*—The anatomical composition of the glands consists, 1st, of an envelope, sometimes purely cellular, and sometimes fibrous, connected by one of its surfaces, either with cellular or adipous tissue, and united by the other with the tissue of the gland: 2nd, of vessels, of some nerves, and of excretory

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glia, which have been named *conglobated glands,* in opposition to the true organs of secretion which receive the name of *conglomorated glands;* certain rounded organs, enveloped in a membrane more or less thick, which sends prolongations into their interior; organs essentially vascular, deprived of excretory canals, which Bichât has separated from the glandular system, and which should be, according to modern anatomists, analogous to lymphatic ganglia, of true sanguineous ganglia, destined to change the blood which circulates through them for the purposes of reparation.

The thyroid body, the thymus gland, the spleen, and the renal capsules, compose the class of these organs which have received the name of *adenoides* or *glandiform* bodies, and of which we are unable to give a general description, on account of the diversities of their forms, their structure, and the obscurity which pervades their true function.

ducts, the extremely fine ramifications of which are united by cellular tissue, and form the proper parenchyma or tissue of the organ. In all the glands, except the kidneys and liver, the parenchyma is divisible into lobes and lobules, which result from the reunion of whitish homogeneous particles. Besides, the fore-named organs present two substances which the difference in their colours makes easily known. In the kidneys, these two substances are disposed in layers, the one *cortical*, the other *internal;* but in the liver, these layers exist throughout simultaneously.

But in what way, with regard to each other, do the extreme ramifications of the vessels and excretory canals arrange themselves, to form the proper tissue of the glands? Ought we to admit, with Malpighi, that the roots of these latter are little vesicles or follicular bags, in the parietes of which the blood terminates; or rather are they excretory ducts, as Ruysch said, the immediate continuation of the latter? Even allowing that this point of minute anatomy is still very obscure, it is to the first hypothesis that we should give credit, following in this the example of the greatest modern anatomists. In fact, the study of comparative anatomy teaches us to regard the glands only as agglomerations of numerous follicles, which belong to canaliculated and ramified prolongations of the tegumentary membranes.

"The muciperal glands, the least complex, which are only simple sacs, furnish the prototype of glandular formation. Let us imagine this sac prolonged, ramified, twisting its branches between those of the vessels, and we shall then have formed of it a gland of the most complicated nature, without even arriving at an immediate communication of the blood vessels with the excretory ducts." (Meckel.)

The excretory ducts, after being reunited to form successively branches larger and larger, and, lastly, one or more trunks, arrive at the tegumentary membrane.

In their course, which is sometimes very long, the trunks often present swellings, sometimes rather small, as those of the mamillary glands; and at other times larger and cystiform; such are those which constitute the biliary and seminal vesicles; the urinary bladder may be considered as an enlargement common to the excretory ducts, which proceed from each of the kidneys, canals which are confounded together, and form one only as far as the skin.

The mucous membrane, which constitutes essentially the glandular apparatuses, becomes thinner in proportion as the ramifications of the excretory ducts multiply; but a cellular tissue, more or less compact, sometimes even fibro-elastic, and in some points an erectile vascular net, or muscular fibres, strengthen and support externally this membrane.

The glands contain many blood vessels and lymphatics; all, except the liver, are supplied exclusively with arterial blood. This latter organ receives, besides its particular artery, a large venous trunk (vena porta), which ramifies in its substance. (See *Vascular System*). In general, the veins of glands do not surpass their arteries in capacity, as happens in the rest of the economy; this is a consequence of the loss which the blood experiences in the interior of these organs, supplied to them by the veins.

*Physical and chemical characters and properties.*—The colour, density, and consistence of the glands vary among each of them, and cannot be described in a general manner. The chemical characters of these compound organs depend

on those of the elementary tissues which concur in their formation: tissues which we have already examined.

*Vital properties.*—The glands are generally but little sensible in their healthy state: the testicle alone manifests a particular sensibility when it is compressed. The presence of calcareous concretions in the excretory canals of some of these organs, and chiefly in those of the liver and kidneys, occasions acute pains. We do not perceive any vital contractions in these organs.

*Varieties from age.*—The glands are developed in the human embryo, in passing through the different degrees of complication which they present in the skin of animals; and this mode of development also proves that these organs are, strictly considered, only various appendages, more or less complicated, of the tegumentary system. In fact, we perceive, from the first, the part of the excretory ducts continued to this system, which afterwards ramifies successively even to the entire formation of the gland.

In the fœtus this species of organ presents lobes and lobulets, which afterwards disappear in some of them, as the kidneys. The volume of the glands which assist in the nourishment of the individual is generally, each proportion considered, more considerable in an early than later age. On the contrary, the breasts, the testicles, and ovaries, destined to the preservation of the species, are little developed before puberty; an epoch at which they acquire more volume and vitality: in old age they cease to act, and fall into a kind of atrophy. The two last species change their situation some time before birth.

*Functions.*—The glands separate from the blood which is carried to them particular fluids, and very different in each

of their species: fluids which are conveyed to the tegumentary surface by excretory ducts. The separation of these products is termed secretion, and differs only from the perspiration and follicular secretion by the more complicated structure of the secretory organ.

Formerly, we did not know the mode of action of the glands, or the function which they performed.

What appears more certain in the glandular secretion, is, that the blood having arrived at the arterial capillary divisions which are distributed into the proper substance of the organ, some of its materials combine, either in virtue of a simple chemical reaction, encouraged by the more or less retarded course of this fluid, or from the influence of a vital power exercised over it by the tissue of the follicles of the gland* ; and from this combination results a particular fluid, formed in the excretory ducts, and carried by them to the surface of the tegument, or reserved, during a longer or shorter period, in their cystiform swellings.

The blood which has not been employed in the formation of this secretion, is absorbed by the radicles of the vascular centripetal system.

### MORBID ANATOMY.

There are few organs which present more congenital anomalies of volume, form, or situation, than the glands. They are sometimes larger and sometimes smaller than ordinary, either primitively (which is most common), or acciden-

* The changes of vitality of a gland, and the state of the nervous system, influence considerably the nature and quantity of the product of secretion.

tally. Their atrophy may result from their compression or from the cessation of their functions. The lobulated structure which is sometimes presented, especially in the kidneys, depends on the imperfection of their development. These latter organs are most subject to variations in number: thus, we sometimes find only one of them, and at other times three. The entire absence most commonly met with, is in those of the ovaries and testicles.

These last species present anomalies of situation: thus, the ovaries are sometimes found in the abdomen, and it happens that one or both testicles remain in that cavity after the age when they ought to descend into the scrotum, and even during the whole of life.

Solutions of continuity of the glands heal with difficulty, and have a tendency to become fistulous, because the secreted humour, flowing in a continual manner through the wound, prevents the reunion and agglutination of the lips of the injured organs.

Glands are very liable to inflammation. This morbid condition assumes in them characters which vary according to their species; and sometimes propagates itself even to the tegumentary membrane. It suspends, augments, or alters their secretion, often determines induration of their tissue, by the combination of this tissue with albuminous or sanguineous fluids effused during the inflammatory process. This induration, generally accompanied by the obliteration of one part at least of the excretory ducts, becomes often scirrhous or carcinomatous when the inflammation continues to exist. These changes are frequently the consequences of chronic inflammations of the breast, the testicles, and ovaries. The various transformations and accidental productions are

observed in all the glands, but principally in these latter. The glandular tissue is never accidentally produced.

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# CHAP. X.

## MUSCULAR SYSTEM.

### SECTION I.

#### GENERAL OBSERVATIONS.

*Definition.*—This system is an assemblage of extremely numerous organs, the muscles (commonly designated by the name of flesh), which compose the greater part of the body, and which present a structure more or less evidently fibrous, but especially contractions, in virtue of which they are the active agents of locomotion.

*Division.*—Struck with the differences of form, organization, and functions, which exist between the external muscles, more or less thick and entire, which act under the influence of the will, and the internal membraniform muscles, the action of which is independent of that influence, Bichât established two muscular systems, which he designated, from distinctive characters the most striking to his eyes, by the names of system of *animal life*, and the system of *organic life*. Latterly, anatomists, having observed that these two systems had between each other similar characters, too important, as respects their organization and properties, &c. to be separated in an absolute manner, reunited them under

the denomination of muscular system, and formed from each of them a division dependent on this latter.

*Structure.*—The muscles are assemblages of extremely minute primitive fibres, reunited in fasciculi appreciable to the naked eye (secondary fibres), which themselves form more considerable bundles, and, reunited to others, compose others still larger. The fasciculi are alone distinct in all the muscles: the bundles are so in the greatest number of them, and, among these, the largest are those which are met with most frequently. To see clearly the fasciculi, the muscles must be submitted to ebullition: they are then easily detached from these organs, under the form of flattened or radiated filaments, which sometimes extend the whole length of the muscle, and at other times terminate, before they arrive at the extremity of the muscle, by uniting themselves to tendons or aponeuroses. The filaments, or secondary fibres, which compose a bundle are parallel; but it is seldom thus with bundles which compose a muscle: these bundles are almost constantly oblique with respect to each other. Examined by the microscope, the fibres appear like fasciculi of fibres still more minute, which appear to be the ultimate division of the muscles: they are for this reason termed *elementary or primitive fibres*, or simply *muscular fibres.* They have especially been well observed by Prochaska, the Wenzells, Antenrieth, Sprengel, Bauer, and Everard Home, and recently by MM. Dumas and Prévost, and by Dutrochet.

We generally agree, at the present day, to regard these fibres as slightly flattened filaments, having throughout the same diameter, and composed of series of corpuscles exactly analogous to globules of blood deprived of their colouring matter; corpusculi which reunite between them a

mucous substance, or one perfectly transparent and gelatinous.

All which has been further said on the intimate texture of the muscular fibre is hypothetical. The latter, and consequently the secondary fibres and the bundles, present, when contracted, transverse folds, which are only temporary folds, which are effaced when the muscle is distended, and increase in proportion as they approach nearer their extremities; this is especially produced by the action of alcohol, boiling, &c.

Besides the proper substance of muscles, a substance which appears to be constituted by globules and the transparent medium in which they are disposed in linear series, there enters also into the anatomical composition of these organs cellular tissue, vessels, and nerves. The tissue forms at first an envelope to the entire organ (common membrane of the muscles); an envelope from which arise external prolongations, which go to furnish sheaths to each of the bundles and fasciculi, and penetrate very probably as far as the elementary fibres; but here this tissue can only be admitted by analogy. Its tenuity and consistence diminish in proportion as it approaches still smaller divisions. (See *Internal Cellular Tissue.*) We meet with fat as well on the interior of muscles as between their bundles, and even between their secondary fibres.

The number and calibre of the vessels in muscles are considerable, and proportionate to the volume of the muscles in each of the two classes which compose their system. The arteries, arriving at the cellular envelope of these organs, divide into two or more branches, which proceed, in following different directions, between the bundles, and afterwards

ramify successively in the cellular tissue of the divisions of the bundles, and in that of the secondary fibres, beyond which we cannot trace them. We are ignorant of the connections of the primitive fibres with the blood vessels of the muscles.

The veins, more numerous and larger than the arteries, form a superficial and deep-seated series. The latter generally accompanies the arteries.

We find some lymphatic vessels. It is not to the presence of these numerous vessels, but to another cause, which we shall presently notice, that the colour in muscles is owing; for this colour is not in proportion to the quantity of the blood which penetrates the organs; and it remains the same, notwithstanding the changes which are observed in the colour of this fluid, in depriving an animal of breathing. The nerves which are distributed to the muscles are very numerous: they are the cephalo-spinal, or ganglionic, according as these muscles belong to the first or second class of the muscular system*.

The same muscle sometimes receives several nerves of different origins. In this case it would appear, according to the experiments of Mr. C. Bell, that the plurality of the nerves has not for its end the accumulation of a greater degree of nervous energy in the muscle, but rather to give to the muscles the capacity of several kinds of motion. However this may be, the nerves penetrate the muscles, in following generally the course of the blood vessels, and in proceeding, sometimes in a parallel direction and sometimes

* We have noticed elsewhere to what part of the cerebro-spinal masses the nerves belong which preside over voluntary motion.

perpendicularly, to the bundles and muscular fasciculi: their divisions soon cease to be appreciable to the eye. The imagination of anatomists has supplied what inspection could not demonstrate for them as respects the termination of the nervous ramifications; and they have supposed, either that the substance of the latter dipped down into the cellular tissue and communicated to it its conductile property, or that a nervous atmosphere emanated from these filaments, and thus extended innervation beyond their termination. More recently, MM. Prévost and Dumas have traced, by the aid of a microscope, the muscular nerves beyond the points where they become invisible to the eye. They have seen that, after having ramified a certain number of times, the nerve expands, that its secondary fasciculi unfold, and eject between the fibres and the muscle, threads, which intersect the others at right angles: these threads afterwards anastomose with other branches or nervous filaments, or return, in forming a duplicature, to the branch from which they were given off. These little transverse filaments are very numerous, and allied to each other.

In general, the little nerves which furnish them proceed in a parallel direction to the muscular fibres; and sometimes two of these nerves proceed together, and send off reciprocally filaments which intersect these others perpendicularly.

It would appear, from these observations, that here the nerves did not possess true terminations; since their ultimate divisions anastomose with the surrounding branches, or go to rejoin their original trunk.

*Physical and chemical characters and properties.* — The muscles present a colour which varies from a greyish white to a deep red, according to the class to which they belong; a colour which appears to be more intense as the muscle is

thicker, and which is almost wanting when we examine isolated fibres.

The colour of muscles arises, not from their vascularity, but from the presence of a colouring matter analogous to that of the blood; a matter which maceration and boiling easily remove, and which disappears at the moment of decomposition.

Muscular fibre is semi-transparent, soft, little elastic, endowed with a power of resistance, considerable during life, especially in its state of contraction, and almost absent after death. It possesses an evident retractility. Boiling, diluted acids, alcohol, and different saline solutions, give more consistence to muscles, and render their fibrous texture more evident.

The chemical analysis of muscular flesh has furnished carbonate of lime, phosphate of lime, soda, and ammonia, a little albumen, gelatine, osmazone, and a considerable quantity of fibrine.

The marked predominance of this latter principle in the muscles establishes a striking relation between them and the crassamentum of the blood, and tends to prove that the globules of the blood and those of the muscular fibre, already identical by their form, are equally so by their chemical nature.

*Vital properties and functions.*—The muscles possess a moderate sensibility in a healthy state, which is considerably increased in certain morbid conditions, such especially as their inflammations. These organs possess the highest degree of *vital contractility*, or *irritability* (Haller); a property on which depends the office they fulfil in the animal economy.

How does this contractility manifest itself? or, rather, in what does contraction consist?

What is evident when a muscle enters into action, is, that it shortens itself, becomes thicker, denser, and harder.

The first of these phenomena being the most important, and the others being only the consequences, it is this which gives to the muscular action the name of *contraction*. It has been enquired whether, during contraction, the muscles gained exactly in thickness what they lost in length; whether their volume increased or diminished, or remained the same.

The best performed experiments, those, among others, of MM. Meckel, Prévost, and Dumas, favour the last opinion. Muscles shrink in contracting; but there does not supervene any alterations in their colour, as some persons have imagined. We are about to examine the changes which the whole muscle experiences when in action. What takes place in its parts which can account for these phenomena? The muscular fibres are placed in a zig-zag manner in their whole extent, and that in such a way, that the summits of the sinuosities which they then form are always the points where the nervous filaments intersect these fibres at right angles. (Prévost and Dumas.) Thus, it is the tortuous direction of filaments which constitutes the contraction. Some have endeavoured to determine the extent of the contraction which they experience. Bernouilli reckoned it as a third of that of the fibre; Prévost and Dumas considered it as a fourth, from the measure of the angles formed by the folds. This last result is confirmed by direct observation.

The actual velocity of the contraction varies according to the muscles; but it is always considerable. In certain muscles, one part of the fibres may remain in rest, whilst

the others contract. This phenomenon is principally observed in those muscles which are supplied with many nerves, as is proved by the experiments of Mr. Charles Bell. (See p. 204.)

The power that muscles display whilst contracting overcomes considerable resistances, and sometimes even destroys the cohesion of tendons and bones. This force is in direct relation to the number of the fibres of these organs. In contracting, muscles acquire elasticity.

It has at all periods been attempted to explain muscular contraction; and there has been assigned to this phenomenon causes, sometimes chemical, sometimes mechanical, according to prevailing theories. Haller, after having overturned these various explanations, believed that he had discovered the cause of contractions, and announced that these took place in virtue of a particular property which he named *irritability*—a property which Bichât has since termed *contractility;* but this is only expressing it in an abstract manner, and not explaining.

We are indebted to Prévost and Dumas for the most ingenious hypothesis which has been proposed upon this subject.

These individuals having observed, as we have said, that the nervous filaments which proceed to the muscular fibres intersect these fibres at right angles, thought that a galvanic current, pervading these filaments, determines their approximation, which cannot take place without producing the tortuous motions of the fibres to which these filaments are attached.

According to this theory, the muscular fibres would be passive in the phenomena of contraction, whilst the nerves

would be the true agents of it. Several physiological and pathological facts tend to support this opinion.

The analogy which is supposed to exist between the cause of the vital contraction of muscles, and that of galvanic phenomena, appears indicated, by the contractions which muscles deprived of life manifest, when they are themselves, or their nerves only, submitted to the action of the galvanic pile. Nevertheless, these are only mere hypotheses, and we know nothing certain upon the probable cause of muscular contractions; but it is not so with respect to the actual conditions of these contractions; for, 1st. *In order that a muscle may vitally contract*, it is necessary (*a*) that it be in a state of health; (*b*) that its communication with the heart by its vessels, and with the nervous centre by its nerves, be not interrupted; (*c*) that the nervous centre be not in a morbid condition, which might destroy its influence upon the nerves. 2ndly. *In order that contraction may take place*, the action of an exciting cause is required: this cause will not be the same at all times, nor in all the muscles. Thus the *will* can act only upon the muscles of animal life, whilst all those of organic life will be able to contract under the influence of active moral affections, of an irritation of the encephalic centre, of a stimulation of the teguments, external as well as internal, near or remote, under that of a sthenic state of the membranes in connection with the muscles which engage our attention, or of the cellulous envelope of the organs, and under that of a direct mechanical, chemical, or galvanic excitation of the muscles, or only of their nerves.

Muscular contractions are also possible after death during a limited time, from the influence of certain stimuli; but we observe on this head, 1st. that the time during which the

muscles remain sensible to an artificial stimulus is not the same in all; 2nd. that each muscle ceases to be excited by a stimulus whilst it remains so by a former, and on this account these organs cannot all be placed in the same class; thus the heart can be no longer excited by galvanic action, so long as it remains under the influence of mechanical stimuli, even after all contractility is exhausted in the body; on the contrary, the external muscles are still excited by the galvanic influence after they have ceased to be so by mechanical irritants*.

Muscular contractility continues from one to twenty-four hours after death. The cause of dissolution and the previous condition of the patient influence much the duration of the cadaverous irritability. If the individual die suddenly (violent death, from apoplexy), other matters coinciding, the muscles retain, for a longer period, their irritability, than in other cases. Should death take place less rapidly, the muscles will contract for a longer time under the influence of external stimuli, as the disease shall have been shorter and less injurious to nutrition.

* Several observers have endeavoured to establish the order of succession in which the muscles cease entirely to contract. Haller, Froreip, and Nysten, have, on this subject, differed considerably in their results. Those obtained by Nysten in his experiments upon decapitated subjects, and animals, would appear to merit the most reliance. Nysten found that irritability abandoned successively the aortic ventricle, the large intestine, the small intestine, and the stomach; the urinary bladder, the pulmonary ventricle, œsophagus, the iris; the external muscles—first, those of the trunk, then those of the lower extremities; lastly, those of the upper extremities, the right ear, and finally, the left.

Among persons who die from the effects of deleterious gases (carbonic acid, sulphureted hydrogen, sulphurous gases, &c.) or narcotic poisons, muscular contractility disappears very rapidly.

When the muscles are no longer susceptible of contracting, under the influence of stimuli, the stiffness and coldness peculiar to the corpse supervene. Nysten considered the first as a last phenomenon of irritability, an opinion opposed to that which considers the nerves as the real organs of muscular contractions: in fact, the cadaverous stiffness is in man and in the series of animals so much the greater, and remains for so much the longer, in proportion as the nerves lose more quickly their galvanic excitability.

Every thing seems to prove that this phenomenon has not any analogy with real contractions; perhaps we ought rather to refer it to those retractions independent of life which certain tissues manifest, and, among others, that which now occupies us, when injured in any way: retractions which Haller attributed to a *vis mortua*, and Bichât to *a contractility of tissue*; but which really afford no explanation of it. Muscular contractions have for their effect, sometimes to impress motions on the solid or liquid parts, and sometimes to maintain both in their actual situation.

The mode of action of muscles and the great variety of its effects, depend on the number, the disposition, the length of the fibres and bundles, &c. but principally on the permanency or mobility of the points of attachment, and on the extent of these latter; thus, sometimes the fibres are attached on all sides to moveable or immoveable parts, or by one portion to a moveable part, and by another to a fixed; and then

each will be approximated towards the other at the time of contraction.

Muscles are named *congeneres* or *antagonists*, according as, compared one with the other, they act in the same or in two opposite directions.

The antagonism is observed especially between the muscles of animal life, and sometimes also between those of organic life; for example, between the sphincters and the muscles of the fecal and urinary excretions. The contraction of a muscle is always accompanied by that of its *congeneres*, and by the relaxation of its antagonists.

When the cause of contraction ceases to act, the organ returns to its first dimensions; a phenomenon which some anatomists consider as a vital act, and not simply the effect of the elasticity of its fibres. This opinion, adopted by J. F. Meckel, does not appear to us to be more capable of being defended with propriety than that by Barthez, who attributed to the muscles a principle of *fixed* situation.

*Mode of development and varieties from age.*—At the first period of the fœtal life, the muscles are lost in the mucous substance which represents the cellular tissue: their fibrous structure is distinct only towards the third month: but the pulsations of the heart, which commence much sooner, indicate an early organization of the tissue in these organs.

The muscles are at first soft, gelatinous, and very pale. According to Bichât, their galvanic irritability is less during the fœtal existence than afterwards; but the experiments performed by Meckel disprove this opinion.

During infancy, the muscles are also paler, softer, and much less fibrinous, than at a later period. Nevertheless,

their motions are at this time more rapid and easy than in succeeding ages*.

In the adult, the muscles are at their maximum of colour, of fibrinous composition, and energy; their forms are more distinct; their motions less rapid, but more steady than in infancy. The muscles in old age grow pale, and acquire hardness and rigidity; their contractions are slow and feeble. In women, these organs are, cæteris paribus, more rounded, softer, and less firm than in men: their contractions are also more feeble, but more rapid.

There do not appear to be any other differences in the human race, connected with the muscular system, except those which result generally from a greater or less salubrity in the kind of life and nourishment; and those also dependent on their degree of exercise.

## MORBID ANATOMY.

Muscles sometimes present irregularities of conformation which are almost always primitive, and consist especially in excesses or defects in length, divisions, irregular attachments, &c.

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* In considering this circumstance as concomitant with the imperfect organization of muscular fibre, and with a great susceptibility of the nervous organs, we are much inclined to regard the nerves as the true agents of contractions.

We often observe their atrophy or hypertrophy. The first is the result of their inactivity, and is remarked particularly in cases of paralysis, or when a musele is submitted to a prolonged compression: the second arises from a too active exercise, and affects only the internal muscles. Among these, it is the heart which is most frequently the seat of hypertrophy.

The displacement (*luxation*) of muscles has been observed only in cases where the aponeurotic envelopes of these organs were divided.

These envelopes are capable of experiencing transverse ruptures in consequence of violent contractions, either between themselves, or antagonists, or from the influence of a sudden and excessive extension. These solutions of continuity take placee chiefly when ruptured, at the point of union of the muscular fibres with the tendons or aponeuroses of insertion. The heart is sometimes ruptured, and that by the effect of its own eontraetions, in some cases of dilatation of its cavities (aneurisms), particularly when the parietes of this organ are at the same time thinner.

When muscles are divided transversely, either by rupture, or by a sharp instrument, the extremities of the solution of continuity separate, and immediate union cannot take place; but the edges of the musele secrete a fluid which fills their interspaces, becomes organized, and acquires the texture and appearance of the fibrous tissue. This intermediate tendinous part separates, and reunites together the two parts of the muscle. We are ignorant whether both these points continue to eontract: what there is eertain, is, that the motions produced by the muscles thus reunited remain for a long time weak, and rarely recover their *original extent and firmness.*

We can conceive, that in proportion as the separation and the tendinous part of new formation are considerable, the longer and more incomplete will be the restoration of its motions. Also, in as much as this union has not acquired its previous firmness and resistance, and that it remains extensible, it neutralizes, in a great degree, the effects of contraction.

Wounds of muscles, with denudation and loss of substance, are covered by a cicatrix, which is formed by a process similar to that which we have described in the first chapter (p. 9).

Inflammation of the proper substance of the muscles is involved in doubt; but that of their cellular tissue is not so, since we find at times purulent collections between the bundles of these organs.

After rheumatisms, we sometimes observe, between these same bundles, and between the fasciculi which compose them, a gelatinous substance. The muscles present, in certain cases, a flaccidity and evident want of cohesion. This morbid condition is sometimes observed in their state of atrophy, and is accompanied, like the latter, with a more or less distinct paleness: it is not equally rare in chronic affections. There has been observed, in some internal muscles, an irregular hardness, which they appear to have acquired. The fatty transformations of the muscles is thought, by Béclard, to be only apparent, and to consist solely in a considerable development of the adipous tissue between the fasciculi of these organs, in cases where their fibres, pale and wasted, are easily confounded with this last tissue.

Instances have been related of accidental osseous productions, or rather of calcareous concretions, found in the muscles Meckel found hydatids between the muscular bundles.

Scirrhus and carcinomatous degenerations rarely affect the muscular tissue. As to the accidental development of this tissue, all the cases which have been related of it evidently refer to morbid productions, the appearance of which alone may produce some illusion. It is thus that sarcoma has been assimilated to muscular flesh. May we consider, as it has been suggested, the development of the muscular texture in the uterus during pregnancy as a kind of temporary accidental development?

## SECTION II.

### OF THE EXTERNAL MUSCLES.

SYNON. Voluntary muscles, muscles of animal life (Bichât). The muscles, properly called.

*Definition.*—We name external muscles all those which, spread beneath the external tegumentary system, and round the osseous parts, are under the influence of the will.

*Situation.*—These muscles are in connection with the osseous or cartilaginous portions of the skeleton, with the skin, with the cartilages of the larynx, with the organs of the senses, the orifices of the digestive, genital, and urinary passages. The greatest number are equal, and situated on each side of the body: others, odd or single, extend more or less from the median line to each of these sides.

*Number.*—Anatomists are not agreed upon the number of these organs; some include in a single muscle bundles which others consider as so many distinct muscles. From the differences of these enumerations, their number varies from three to four hundred.

*Volume, form, and disposition.*—There exist great differences between the muscles with respect to size. To convince ourselves of this, we need only compare the cruræus, triceps, adductor femoris, and certain muscles of the trunk which form considerable masses, with those extremely mi-

nute muscles belonging to the auditory apparatus. The other parts of this system occupy, in this respect, a variety of intermediate degrees between these two extremes. The muscles may be divided, as regards their form, into *long*, *thick*, and *short*.

The *long* belong more particularly to the extremities, and the *thick* to the trunk. The *short* are found especially on the head, neck, hands, feet, and generally round the short bones. The form also of the muscles which compose each of these classes varies much.

The greatest number of these organs present tendinous or aponeurotic extremities, which receive then, the one the name of *origin*, and the other that of *insertion;* whilst their middle, or fleshy part, is termed *body* or *belly*. Sometimes the belly forms a single bundle, and sometimes it is composed of several very distinct bundles, separated by cellular interspaces. This is what is seen in the deltoid and the glutei. At other times, the body of the muscle is interrupted in its length by tendinous parts, which divide it into several bellies. The digastric, the rectus of the abdomen, &c. present this disposition.

In certain muscles, one of the extremities divides into two and even three portions; such is the case in the biceps and triceps of the arm and thigh, &c. We may compare some serrated muscles of the trunk with those which present also compound extremities. Other muscles, separate in their whole extent, have a common tendinous extremity; such are the latissimus dorsi and teres major, which are inserted by a single tendon into the humerus.

The muscles are symmetrical on each side of the median line: the diaphragm is alone an exception.

These organs are almost always attached, through the medium of fibrous parts, to the periosteum, the perichondrium, and to the organs of the senses. The fleshy fibres of the *peauciers* or *cuticularis* (panniculus adiposis in animals) furnish an exception to this; being inserted directly into the dermis, the tissue of which, as we have seen, approaches very nearly to the fibrous. The muscular fibres are often inserted into the membranous prolongations which the aponeurotic envelopes send between the muscles.

*Structure.*—The bundles and fasciculi of which the muscles are composed are much more evident in the external than in the internal. Some of the external present bundles so very large, that they may be taken for so many distinct muscles. The fibres present here reciprocally varied directions, and are sometimes parallel with each other, sometimes radiated. In the first case, their assemblage presents a straight direction, or proceeds obliquely, either between two aponenroses spread over one part, or over the whole of the muscle; either upon a tendon concealed at first in the interior of a muscle, and which often presents on its free surface the appearance of the stem of a pen with the beards on one side only, or on both at the same time: hence the names of penni and semipenniform muscles. It would be foreign to our subject to relate the various connections of the muscular fibres, either between themselves, or with their tendinous parts of insertion or intersection: these details belong to descriptive anatomy.

We shall only observe, that the connection of the fibres with the other parts is very intimate. The abundance of the cellular tissue of the muscles is in direct relation with their volume, the size of their bundles, and the interspaces

which separate these parts. We have seen, in the general considerations, how the vascular system in these organs is supplied: their nerves arise from the spinal marrow and medulla oblongata, and are very numerous.

Some muscles (those of the neck, of the pelvis) receive, besides, ganglionic nervous filaments.

*Physical properties.*—The colour of the voluntary muscles is of a well-known lively red. The density and power of resistance of these organs are, as we may suppose, in proportion to the number of their fibres, and surpass those of the muscles of organic life, &c.

*Vital properties and functions.*—The sensibility of the voluntary muscles is little observable in their healthy state. They contract with great energy and promptitude under the influence of cerebral action; and, when they are withdrawn from this influence, the galvanic stimulation of their nerves determines their contractions.

The attitude of the skeleton, its movements, those of the organs of the senses, of the skin, voice, speech, deglutition, the retention and expulsion of excrementitious matters, are the result of contractions of these muscles.

The motions are simple or compound: they are simple when they take place in the sense of contraction; compound, when the muscles which produce them have two or more different directions.

We know what is meant by *congeneral and antagonist muscles.* These general denominations comprise those of the flexors and extensors, abductors and adductors, pronators and supinators, &c. We generally remark between the antagonist muscles differences of power, which have not been studied, except in those which perform the motions of flexion

and extension. Since Borelli, these differences have been considered as superior in the extensors; but it would appear that this opinion is true only with respect to some parts of the body, such as the superior extremities.

There exist in the disposition of muscles some circumstances which require on their part a considerable power for the production of motions: these are—1st. their office of motive powers as levers of the third kind; 2nd. the very acute angle which they generally form with the bones; an angle which is, indeed, rendered more evident by their insertion to the apophyses, or to their enlarged extremities; 3rd. the resistance of the antagonist muscles.

We will not class among these circumstances the obliquity of the fibres as respects the tendons upon which they are inserted, since this obliquity allows the increase of these fibres, and thus amply compensates for what they lose in power in each of them. As to the frictions of the tendons and of the articulating surfaces, they are so much facilitated by the presence of sheaths and of synovial membranes, that they can hardly be classed among the number of the obstacles, which are to be overcome by the muscular power. Dependent on the two first circumstances which we have stated as opposed to muscular power, we may remark, 1st. that, if the levers of the third kind are the most difficult to move, they are also the most favourable to extent and rapidity of motions; 2nd. that the facility of motions is essentially connected with the form of the body; and that this form would be very disadvantageous to locomotion, if the muscles were attached to the bones at right angles: we can, besides perceive, how greatly the extent of motion would be limited by such a disposition.

## SECTION III.

### OF THE INTERNAL MUSCLES.

SYNON. Hollow muscles, involuntary muscles, muscles of vegetative functions, muscles of organic life.

*Definition.*—The system of the internal muscles comprises the fleshy parts which enter into the structure of the organs of involuntary functions; these parts are the heart, and the planes of muscular fibres which line the internal teguments, and their bronchial, genital, and urinary prolongations.

*Situation.*—These muscles are all deep seated, and belong, the heart excepted, to the internal tegumentary system.

*Volume, form, and disposition.*—The volume and form of these fleshy parts depend, generally, on those of the hollow organs, to the structure of which they concur. They constitute muscular layers more or less thick, which strengthen externally the internal membrane of these organs. These layers, very thin and limited in the alimentary canal and bladder, more numerous and thick in the heart, and always intermixed together, are in general circular; in the œsophagus and large intestines they are observed to be longitudinal, which intersect the circular at a more or less right angle, and are external to them.

*Structure.*—The fibres which compose the muscles of organic life, are sometimes interwoven, at other times in juxta-position and reunited in flattened bundles: when thus united, they sometimes form nearly complete rings; as in the greatest part of those of the intestines.

In general, these fibres are short; those even which compose the longitudinal bundles of the œsophagus and large intestines, far from having the length of these bundles, terminate, after a short time, to give room to others; they are more or less distinct according to the organs examined; those of the uterus are only slightly so during pregnancy. We find tendinous parts in the heart, only at the extremities of its fleshy columns, at the entrance of its cavities, and in the auriculo-ventricular valves; the fibres of the other internal muscles terminate in the submucous cellular tissue; the consistence and organization of which we have elsewhere described, as analogous to the fibrous system.

These organs present but little cellular tissue: their vessels appear to be more numerous than those of the external muscles; but as it has been remarked, we must not consider all the vascular branches which penetrate into their tissue as belonging to these muscles; for the greatest part of these vessels proceed to the internal teguments. The nerves of these muscles are less numerous than those of the preceding; the greatest number arise from the ganglia, and anastomose in some organs with the cerebro-spinal: this is what we observe in the œsophagus, the stomach, the rectum, and the bladder.

*Physical characters.*—The muscular fibres which cover the internal tegument, are pale and greyish; those of the heart are of a much deeper red than those of the voluntary

muscles. Bichât thought that the muscular fibres of organic life are more resisting than those of animal life; the contrary appears to be most probable, unless there is in this respect a difference between both, which is not proved.

*Vital properties and functions.*—The sensibility of the involuntary muscles is very obscure, and can only with great difficulty be appreciated and distinguished from that of the tissues to which these muscles are united. Harvey relates the case of a man whose heart, exposed in consequence of caries of the sternum, could be irritated without the patient experiencing any pain.

Bichât supposes that the first sensation of hunger results, partly, from the long duration of the state of contraction of the muscular fibres of the stomach. The contractions of the muscles of organic life, are determined physiologically by the contact of certain agents; such as the blood for the heart; food, chyme, chyle, and the excrementitial residue for the muscular fibres of the digestive canal; the urine for those of the bladder: we must remark, that these different subtances stimulate these organs only through the medium of the mucous or vascular tunic which surrounds them.

These contractions may be equally produced by mechanical stimulants; on the contrary, galvanism operates on them with difficulty, compared with the facility which it exerts on the irritability of the voluntary muscles. A variety of morbid conditions of the system determine or accelerate, sympathetically, muscular contractions of the heart and of the sub-mucous fleshy layers; but most frequently those of the heart.

Acute moral affections give rise to the same results;

also the muscles of organic life are more or less independent of the cerebral action.

We are not able to suspend the contractions of the heart, as performed by Bayle, who had this power, and of which Cheyne also relates the case of a man who equally possessed it: nor can we either, by a direct act of our will, contract our alimentary canal; and the influence of the latter on the urinary and fecal excretions may be easily explained, by that which it exercises over the external muscles which assist in these functions.

At the same time, this independence is found in many affections where the cerebro-spinal nervous system is injured, without the muscles of organic life being implicated; yet this independence is not absolute, and many diseases of the brain and spinal marrow paralyse more or less quickly these organs; the bladder and rectum are thus particularly circumstanced, arising from the nerves which they receive from the spinal marrow; also injuries of the marrow, which give rise to paraplegia, occasion most frequently a simultaneous paralysis of these parts.

The contractions of the internal muscles serve to astringe and shorten the hollow organs of which they form a part; the variety which is observed in the direction of their fibres was necessary, that this contraction might accommodate itself to the form of these organs, and take place in all directions.

There results from this an action, communicated to the solid or liquid matters contained in these organs, which convey these substances from one part to another, or expel them from the economy.

The internal muscles have not antagonists like those of the external. Sometimes they appear to exercise a kind of

antagonism; thus, 1st. foreign substances distend the parietes of the hollow organs of which they form a part. 2nd. the different parts of some of these organs, with regard to each other; for example, the auricles of the heart with respect to its ventricles (the auricles being at the height of their contraction, when the ventricles are at that of their relaxation, and vice versa), the neck of the uterus and of the bladder with respect to the body of these organs: 3rd. the longitudinal fibres of the digestive canal in relation to its circular fibres; the contraction of the longitudinal giving place to the elongationof the circular: 4th. sometimes in the voluntary muscles; this occurs in the sphincters of the anus and of the bladder, with respect to the muscular fibres of these organs; in a word, those of the bladder relax, while the others contract. At times, also, the external muscles act as congeneres to the internal. Thus, after vomiting, the act of the expulsion of the fæces or urine, of parturition, the abdominal muscles contract at the same time as the stomach, rectum, bladder, and uterus.

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# APPENDIX.

## ON ACCIDENTAL TISSUES.

To complete the history of the anatomy of the tissues met with in the economy, it remains for us to speak of those which are accidentally developed. They are divided into those which have more or less analogy with certain primitive tissues, and into those which have no analogy with healthy organs. The first often constitute real accidental productions, and sometimes simple transformations: we have already noticed the systems to which they approximate by their appearance, and sometimes by their organization; and we shall only consider here the accidental tissues which differ from the character of the primitive organic formations.

Each of these tissues, presenting varieties according as they are examined in different parts, at various periods of their existence, approximating to others by very delicate shades, and being found besides combined with several of the latter, have given rise to various modifications in their classification, which it is unnecessary to notice here. We shall treat of the morbid tissues which are most generally

admitted and best characterized, and shall successively describe, tubercles, scirrhus, cancer, or encephaloid tissue according to Laennec, and melanosis*. But before we commence their particular history, let us point out in a summary manner their general characters, and the principal opinions which have been advanced upon their cause, and on their mode of development.

Morbid tissues may be developed in all parts of the body; but they are most frequent in those which present a more vascular organization. They are found most commonly in a single part; however, they sometimes exist in several simultaneously.

The relations of situation of these tissues with the organs may be referred to two kinds: in one of these, they occupy the interstices of the substance of the organ: the volume of the organ is then augmented, and its substance, surcharged and compressed by the presence of the morbid production, wastes and disappears. In the second kind, the foreign body, forming external to the organ, displaces or destroys it, by the compression which it exercises upon it, and finishes, as in the preceding, by occupying its place.

Some authors consider these tissues as morbid developments of the primitive tissues; others, on the contrary, believe that they constitute new productions, which are developed in the centre of these tissues. M. Meckel, among others, admits that, by an aberration of the nutritive process, analogous to inflammation, there is produced in the or-

* Other tissues admitted by Laennec, namely, cirrhosus, sclerosis, and the squamous tissue, do not appear to have been sufficiently studied even to this day, to enable us to describe them with precision.

gans an effusion of albuminous fluid, which becomes imperfectly organized, and takes on the different forms of the original tissues. It is likewise to an inflammation of the capillaries, and especially of the lymphatic capillaries, that M. Broussais attributes the production of these accidental developments. On the contrary, Bayle and Laennec attribute this phenomenon to the effect of a particular morbid diathesis. This latter opinion is professed by very few: the greatest number of anatomists and pathologists coinciding with the opinions advocated by Broussais and Meckel.

The accidental tissues which have no analogy with those of the economy do not present in general any apparent texture, except containing, for the most part, vessels and traces of cellular tissue.

Their consistence undergoes inverse changes, to those which the primitive tissues experience, from their first period of formation to the moment when they are appreciable; that is, instead of augmenting, they gradually diminish; so that these tissues, moderately hard in their first period, that of their *crudity*, soften and even ultimately become dissolved. They endeavour to detach themselves from the economy, and exist there but a limited period. Instead of assisting in any function, they at first impede mechanically the action of the surrounding organs, or of those into which they are infiltrated; produce often their inflammation; and later, when decomposition takes place, occasion very serious general disorders, more particularly emaciation and hectic fever; of which death, more or less rapid, is the ordinary consequence. At this stage also, these productions have a great tendency to increase; and sometimes present themselves, either in a simultaneous or successive manner, in several

parts of the economy, which then would appear to be the seat of a general infection.

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## FIRST ARTICLE.

## TUBERCLES.

Tubercles are homogeneous, casiform productions, which are sometimes found infiltrated in the areolæ of our organs, and sometimes collected in masses more or less large, and generally rounded.

They are met with principally in the lungs, in the tissue of the lymphatic ganglia (scrophulous tubercles), in the cellular tissue, and on the surface of serous and mucous membranes: there is no organ in which they may not occur.

The tubercular substance is at first fluid and whitish, then acquires more and more consistence. It becomes yellow, and assumes the appearance of cheese; the tubercle is then said to be in its state of *crudity*. There is sometimes formed around it, at this period, a rather soft membranous envelope, which, somewhat later, often presents changes which will be presently noticed.

Such is the progress of development of tubercular masses. We cannot discover in them either vessels or cellular tissue; in fact no traces of organization.

At the end of a variable time they undergo a softening, which commences at their centre and gradually extends to their circumference. The tubercles are then reduced, sometimes into a semifluid, opaque, yellowish, homogeneous, substance,.

sometimes into flakes similar to the caseous matter of milk. In this state the tubercular matter forsakes the centre, where it was collected, and forms a passage to escape from the body : sometimes then the cavity which it occupied disappears, in consequence of the approximation and adhesion of its parietes ; in other cases, it remains. These parietes, generally formed by the new membrane, which served as the cyst to the tubercle, continue to secrete a puriform matter ; or this membrane, at first very analogous in its organization to the mucous teguments, becomes cartilaginous or even osseous, of which Laennec has lately related a case at the Royal Academy of Medicine.

Bayle considered tubercles as a production, *suî generis*, different from the transparent greyish miliary granulations, of which he has left us an excellent description.

Laennec, in admitting the particular nature of tubercles, and in attributing them, like Bayle, to an individual and specific diathesis, differs from the opinions of this author in considering the miliary granulations as the first degree of development of the tubercular masses.

M. Broussais also, not distinguishing these granulations of the tubercles, announced that both consisted in an alteration of the lymphatic ganglia, the consequence of an inflammatory process*. Lastly, M. Andral, jun. has been induced, from an attentive examination of pulmonary tubercles and granulations, both in men and in horses, and by a minute dissection of the lobes of the lungs, to conclude: 1st. that the granulations of Bayle are not incipient tubercles, but

* Morton and Portal had already described pulmonary tubercles as obstructed lymphatic ganglia.

portions of the pulmonary lobules separataly inflamed*.: 2nd. that pulmonary tubercles are not formed by a *tissue*, for they do not present the anatomical characters of that; 3rd. that they are the product of a morbid secretion, preceded by an active sanguineous congestion, which does not necessarily constitute an inflammation; 4th. that it is probable, but not proved, that the lymphatic ganglia of the lungs are sometimes the seat of tubercles (the lymphatic vessels of the lungs and other organs sometimes contain a matter which appears identical with that of tubercles); 5th. that tubercles are met with in several of the tissues which compose the lungs.

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## SECOND ARTICLE.

### SCIRRHUS.

Scirrhus, which is often confounded under the name of cancer of the encephaloid substance, is a very hard tissue of a whitish or bluish hue, which presents itself ordinarily under the form of irregular masses; it is frequently met with at the neck of the uterus, at the pyloric orifice of the stomach, in the glands, &c. there are few organs in which it may not occur. The scirrhus tissue has, in its state of crudity, the consistence of the fibro-cartilages.

We observe, in its organization, traces of cellular and

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* The lymphatic ganglia often assume the physical characters of these granulations in their inflammations.

fibrous tissue, and rarely vessels. Sometimes it presents, internally, areolæ and regular radiations, similar to those in turnips. This tissue softens, and is converted into a transparent gelatinous or siropy substance, sometimes colourless, at other times reddish, or fawn, or of a greenish grey colour. Lastly, the scirrhous tissue presents several varieties, and among others those that Abernethy has described under the names of tubercular, mammary, and pancreatic sarcoma. The first is distinguished from scirrhus by its lobulated form.

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## THIRD ARTICLE.

### OF THE ENCEPHALOID OR CEREBRIFORM CANCER.

The tissue to which M. Laennec has given the name of *encephaloid matter* is one of those which anatomists designate under the name of cancer, that which has sometimes been termed *spongy inflammation* (Burns), *fungus hæmatodes* (Hey and Wardrop), and *medullary sarcoma* (Abernethy).

This tissue is often met with in the uterus, in the ovaries, the testicles, the mammæ, the brain; it has been observed in all organs.

It presents itself under the form of lobulated masses, similar to the convolutions of the brain; these masses are sometimes covered, in a part or wholly, by a membranous production, united to it by a loose and very vascular cellu-

losity, and which often acquires the consistence of cartilage. In some cases, the cerebriform matter is infiltrated into the tissue of the organs; this is what takes place especially in that of the uterus.

In its state of crudity, the encephaloid tissue is whitish, reddish, or violet, either partially or uniformly; it is less consistent than the scirrhus, and more so than the substance of the brain. It is traversed by blood vessels, the parietes of which are very thin and fragile, and which proceed from those which are found in the soft cellular tissue, with which the encephaloid masses are surrounded. Notwithstanding the analogy which exists between the encephaloid and the cerebro-spinal nervous masses, both as respects their form and that of their apparent texture, we cannot admit the identity of their tissues.

The cerebriform cancer softens very gradually, and is then reduced to a pultaceous matter, of a white, more or less tinged with red, and sometimes greyish matter, which presents also some resemblance to the substance of the brain, when affected with softening (ramollisement).

It often happens in this stage, that the vessels of the accidental tissue give way, and allow a considerable quantity of blood to escape: in these cases, sometimes this fluid passes out of the economy at the period of rupture, sometimes it overflows, and is carried off as we have seen takes place in the cerebral tissue, in those cases of sanguineous apoplexies in which death is not the immediate consequence.

The contact of the air accelerates the softening of the cerebriform matter, and its putrid decomposition.

## FOURTH ARTICLE.

### OF MELANOSIS.

M. Laennec has given the name of melanosis to a black opaque accidental production, which many persons had named before him, and which some authors consider a variety of cancer (Meckel), or tubercles (Broussais).

We meet with the melanose substance either in masses, in which the number, volume, and the form vary much, either infiltrated into a great number of organs, and chiefly in the lungs, in the cellular, glandular, and muscular systems; on the surface of serous and mucous membranes, in the lymphatic ganglia, &c. When it exists in masses, they are united to the ambient tissues by cellular tissue, transversed by vessels which do not enter into its substance.

This substance unites to its black colour and opacity much consistence and tenacity: we cannot discover in it any appearance of texture. By its softening, which takes place very slowly, the melanose matter is converted into a blackish *deliquium*, which, if it does not escape immediately from the economy, may be absorbed, and colour the surrounding fluids and solids.

This softening does not so materially influence the general health as that of the preceding productions.

The chemical analysis of melanose matter has discovered in its composition much fibrine and colouring matter of the blood, a little albumen, much phosphate of lime, the oxide of iron, the carbonate of soda, and the chlorate of sodium.

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